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UNIVERSITY EXPANSION IN GREAT BRITAIN*

THE report of the Ministry of Education on "Education in 1949" presents several features of interest to the scientific worker, apart from his general interest as a citizen, in its survey of primary and secondary education. First among these features may be mentioned an account of the work of the National Advisory Council on Education for Industry and Commerce on the further development of higher technological education in Great Britain, with special reference to the part which the major technical colleges could play. The Council considered that a wise policy would encourage the development of the excellent traditions that have been built up by the technical colleges in close association with local industries, and would encourage young people in industry to do their best by promising them an award as high as any that existed for their particular industry. An interim report on the future organisation of higher technological education has been prepared with these considerations in mind, and submitted for comment to the universities, local authorities, professional institutions, technical colleges, industry and interested government departments.

"Education in 1949" draws no clear distinction between technical and higher technological education, and there is nothing to indicate that the National Advisory Council appreciates the distinction that emerged so clearly in the third report from the Advisory Council on Scientific Policy, which supported the proposal to establish one or more colleges of applied science, with governing bodies of their own but fitted into the university system. The comments of the Advisory Council on Scientific Policy on this interim report issued by the National Advisory Council will doubtless appear in due course. Meanwhile, the Ministry of Education records steady progress by the regional advisory councils for further education, although there was little, if any, improvement in the accommodation for such education; the available accommodation tended to set the limit, and not the reluctance of employers to release young people, or the unwillingness of local education authorities to make arrangements. Indeed, one of the most striking features of further education in Britain since the War has been the steady rise in the number of young workers who are released by their employers during working hours, usually for one day or two half-days a week, to follow educational courses. In 1949 the total was 224,000, compared with 190,000 in 1948 and 167,500 in 1947. The five national colleges continued to make good progress, the Rubber College and the Heating, Ventilating, Refrigerating and Fan Engineering College completing their first year's work, and the Aeronautics and the Horology and Instrument Technology Colleges entering their third year.

Information in the report regarding the supply and training of teachers is rather meagre. The

* Education in 1949: being the Report of the Ministry of Education and the Statistics of Public Education for England and Wales. (Cmd. 7957.) Pp. ix + 236 + 8 plates. (London: H.M. Stationery Office, 1950.) 5s. 6d. net.

Ministry does not normally obtain information about vacant posts in schools, and the only reference to the scarcity of qualified science teachers in the schools—a problem of much concern to the Advisory Council on Scientific Policy, which was also discussed at the Federation of British Industries' Conference on Industry and the Universities last November—is a statement that information from a variety of sources showed that many schools, especially girls' schools, had considerable difficulty in filling posts in science and mathematics with suitably qualified teachers. The seriousness of the present position, so far as teachers of science are concerned, was emphasized at the Birmingham meeting of the British Association, when the Division for Social and International Relations of the Association arranged a special discussion on the subject. The Ministry has already suggested to the National Advisory Council that the Council should investigate as an urgent matter the requirements of the schools for graduate teachers, and the best ways of meeting them.

One result of any such inquiry should be to help the Ministry to fix a date terminating the system under which university students receive grants as intending teachers for the whole of their university career, including their degree course, in return for a pledge "to take a course of training after their degree course and to take up the profession of teaching". It should be noted, however, that already more than two years have elapsed since the Working Party on University Awards made an emphatic recommendation that the system should be abolished "within the next three years". The other main determining factor with the Ministry is the development of an adequate system of university awards not earmarked for teaching or any other specific profession.

The chapter in the report dealing with the question of university entrance scholarships and other awards gives outstanding interest to the present report. Here is presented for the first time an account and appraisal of the Ministry's part in the Further Education and Training Scheme for Ex-Service Students, and an appreciation of the issues that are raised for the universities now that this scheme, which is correctly described as a large-scale, intensive and emergency effort to make good the educational wastage of the War, comes to an end. That end, while in sight, is still some way off, for, of the 8,641 awards taken up for the first time in the academic year 1949–51, any given for lengthy courses of training for medicine or dentistry, for example, will continue for at least six years, and 41,947 awards were still current at the end of 1949. Men called up for national service after September 1947 are not normally eligible for awards from the Ministry of Education, and during 1951–52 there are likely to be few, if any, new awards, other than those which for one reason or another have been held over from previous years.

Before the War, 16,000 out of 40,500 students were 'assisted'—roughly two in five—as against 38,000 out of 55,000 in the immediate post-war years—more than two out of three. During the past year, more than half the assisted students held other grants. Of the 83,133 awards made by the end of 1949, 22,314 were given to students likely to enter a branch of the teaching profession, 11,283 to students of some branch of engineering, 4,949 to medical students, 2,350 for industrial chemistry, 1,196 for dentistry and 1,020 for pharmacy. Of the total, 43,741 were held at universities; 22,727 of them were current at the end of 1949, including 4,183 new awards made in the academic year 1949–50. From the beginning of the scheme in 1943 to the end of the financial year, 1949–50, the cost is estimated at £33,500,000 on maintenance and £9,100,000 on fees.

With the termination of the Further Education and Training Scheme, students will have to rely for financial help mainly on the future system of central and local scholarships. Clearly, in the next two or three years there will be a sharp decrease in the ratio of assisted students, or there must be a sharp increase in the number of new awards. The Ministry has already plans to increase the present 900 awards to 2,000, and the supplemented awards made by local education authorities are only 700 short of the target of 2,000 set by the Working Party.

Nevertheless, although the Minister, in a circular issued to local education authorities last October, made it clear that arrangements for maintaining an adequate number of university awards should proceed concurrently with the termination of the further education and training schemes, and that discussions between universities and local education authorities on a new procedure for local awards in accordance with the Working Party's report should proceed, the Ministry's report sounds a note of caution. It is not, of course, possible to equate the cost of the scheme with its value judged by results, quite apart from the fact that what contribution to the country's welfare will be made by those who have been trained under the scheme remains to be seen. The Ministry has done well to arrange to maintain touch so far as possible with those who have held grants under the scheme, with the view of finding out from them in a few years time how their training has helped them in their careers. Nevertheless, as the report points out, the fact that numbers of students who had obtained admission to courses of university standard failed in their studies is significant, and should be borne in mind when questions of the expansion of universities or of future scholarship policy are under consideration. In the face of that fact, it can scarcely yet be maintained that the system of admissions to universities is so nicely adjusted that the fact of a candidate's admission alone justifies spending public money on him. Hence, while universities must carry the responsibility for selecting students, it is desirable that among themselves and in concert with the schools they should seek to evolve new and more satisfactory means of selection, even if it means strengthening considerably the academic staff responsible for selection.

The case for experiment in this field of selection is supported by the further observations in this report on university expansion. The fact that the universities have coped successfully with inflated numbers

in a state of emergency does not of itself imply that numbers should necessarily be maintained at much the same level in the future. With the expenditure on university awards at a level of £40 million, there must be some relation between the number of university students and the number of graduates needed in our national life.

From this point of view the Advisory Council on Scientific Policy was altogether too restrained in its comments on the inadequacy of the Ministry of Labour's Survey of Scientific Man-Power. It is imperative that other means should be found of providing the type of information desired, and the Advisory Council could well have issued a firm recommendation or directive rather than expressed a faint hope. It may do no harm to assume for the present that the annual intake to universities should be maintained at its present level, and with it a level of output of graduates in science according with the recommendations of the Barlow Committee. Meanwhile, a gradual increase of open, State and local awards, as suggested in the Ministry of Education's report, may confirm the new opportunities suggested by the Further Education and Training Scheme, and go far to secure that well-qualified candidates are not debarred from a university education by reason of lack of means.

There should, however, be a limit to the term during which university expansion and university awards are not related to some reasonably accurate knowledge of the country's need of graduates. It also remains to be seen how large a number of students can attend universities and other higher institutions without depressing the general intellectual standard. Both the last report from the University Grants Committee and the statement from Nuffield College on the problems facing British universities indicated some concern as to the maintenance of standards. One reason for placing on the universities the full responsibility for selection of students is that they would thereby be able to control their size, and thus ensure the maintenance of academic standards, by the number of recommendations for awards which they made.

Desirable as is such a policy, it carries implications which are not always recognized. For the universities it involves, as already indicated, a readiness to experiment with methods of selection, so as to make them as fool-proof as is possible, and to devote increasing time and care to the selection of students and the difficult problems that may arise as between one university and another, for which the idea of a university clearing house has been suggested as one possible solution. It means, too, that the essential decisions regarding the expansion of the universities must have reference to some reasonably reliable estimates of the number of students who are adequately equipped to benefit substantially from a university training, and to the recognized needs of the nation for trained graduates. If in this way the policy of university expansion and of university awards is firmly based on broad considerations of national and social policy, the case for whatever grants are required to implement details of that policy could be cogently and convincingly argued at the national or the local level. There should then be little risk that the relatively narrower financial considerations would impede the making of awards.

ANIMAL ECOLOGY

Principles of Animal Ecology

By Prof. W. C. Allee, Prof. Orlando Park, Prof. Alfred E. Emerson, Prof. Thomas Park and Karl P. Schmidt. Pp. xii+837. (Philadelphia and London: W. B. Saunders Co., 1949.) 14 dollars.

THIS is a book of more than half a million words, with a bibliography of about 2,500 titles, and with more than three hundred text-figures and tables. Its five authors rank high among the exponents of animal ecology in the United States, and they have written of their subject not only at length but also comprehensively. Their book cannot fail to be a landmark in the development of animal ecology in this century.

After an introduction and a history of ecology occupying seventy-two pages, the material is arranged in four sections, each of which might stand as a separate work. The historical section represents the point of view of the Chicago school of ecology, to which active and influential group all five authors belong. The second section deals at length with the physical factors of the environment and briefly with some biotic factors. Although it covers much the same ground as the first part of Chapman's "Animal Ecology" (to which pioneer book the historical section scarcely does justice), this section is made useful by the inclusion of a good deal of modern work.

Section 3, on animal populations, will be welcomed by everyone interested in this field, for it supplies a long-standing want. Several recent reviews have summarized particular aspects of the subject; but here is a work of nearly a hundred thousand words bringing together a vast amount of information, and providing a well-balanced and authoritative discussion of it. This section should be reprinted as a separate volume so that it could come more readily to the attention of those concerned with human populations.

The largest section is entitled "The Community" and is an attempt to bring order to biotic ecology without recourse to the repellent lists of communities that fill page after page of some text-books. The subdivisions used are community structure, metabolism, periodicity, development and distribution. This approach represents a reaction from the recent American trend and a considerable return towards the arrangement that was used by Elton in his book of 1927.

The final section, on "Ecology and Evolution", ranges widely over some of the less tangible fields of biology and attempts to treat genetic variation, isolation, adaptation and natural selection from an ecological point of view. This aim involves a good deal of repetition, but was probably necessary to complete the authors' design. Readers who are not already acquainted with recent books by Mayr and others will find here many suggestive ideas.

There can be no doubt that this is an important book—important for the encyclopædic range of its contents, for the high authority of its authors, and

for the influence it is likely to have on animal ecology, particularly in the United States. On that note, and with a strong recommendation to librarians and those who have need of a reference book of ecological data, it would be agreeable to stop. But it is a reviewer's duty to evaluate, and he may properly be asked whether, in the opportune circumstances, it is enough for this book to be important.

The great fault of the work is that it is grossly overloaded. One is led to the suspicion that the authors conceived themselves to be writing a text-book for the use of students without background of scientific knowledge who were to be saved the trouble of consulting any other work, whether of physics or geology or another science. Paragraphs such as those on Occam's razor (p. 5), gravity (p. 131) and vibrations produced by non-living forces in Nature (pp. 139–40), and elaborate statement of facts so obvious as that deer forage over wider areas than mites and that birds move greater distances than sloths (p. 490) not only steal space in the book and the reader's time but also raise doubts of the authors' judgment.

As a result of this overloading, and its consequent size, the book belies its title. If it does contain the principles of animal ecology, those beacons of which the subject stands so much in need, they have been smothered in facts of a low order of generality. It is mainly in this respect that the book, important as it is, fails to deserve higher praise. As an encyclopædia of animal ecology it will be used gratefully; but the authors owe us another book, with the title of this one and fewer than a fifth of its words, revealing what they conceive to be the principles of their subject.

GEORGE SALT

REVIEW OF ORGANIC CHEMISTRY

Recent Advances in Organic Chemistry

By Dr. Alfred W. Stewart and Dr. Hugh Graham. Seventh edition. Vol. 2. Pp. ix+447. 35*s*. net. Vol. 3. Pp. xi+387. 38*s*. net. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1948.)

ONLY Vol. 2 of the previous edition has been revised and extended into two volumes for the seventh edition, so that there is no Vol. 1 to this new edition. Vol. 1 of the sixth edition (1931) is out of print but "is no longer regarded as dealing with *recent* advances in organic chemistry and is therefore mainly of historical interest". It would have facilitated finding topics if each volume had contained lists of contents of the other two volumes. Perusal of the tables of contents of these two volumes reveals that three-quarters are devoted to natural products while one-eighth can be regarded as covering theoretical topics. Important though work on natural products has been, without doubt the outstanding advances of the past quarter of a century have been in theoretical organic chemistry, from the application of electronic concepts to molecular structure and reactivity and thence to the mechanism of reactions. In this light the division of material seems disproportionate.

Vol. 2 opens with an essay entitled "Organic Chemistry in the Twentieth Century". The reader has not far to go before encountering "By far the most interesting set of compounds prepared in the last quarter of a century has been the derivatives of various elements in a state of abnormal valency. Gomberg's triphenylmethyl seemed at first likely to remain without a parallel; but in recent times a perfect flood of abnormalities has been let loose . . . have forced upon the notice of chemists the fact that the old and apparently well-tried dogma of the permanent quadrivalency of carbon is in a very shaky condition"—rather disconcerting phraseology for 1950, while it is clear that the "last quarter of a century" refers to 1900–25. Then on p. 11, "During the last twenty years, the constitution of benzene has been discussed from almost every possible standpoint, and we are certainly not less wise than when the discussion began. Whether we are wiser is a more doubtful matter"—and the structure of benzene is not further referred to, and aromatic substitution is dismissed with a footnote reference to Holleman's book of 1910. On p. 18 it is stated that "In the whole field of stereochemistry no more puzzling phenomena are known than those grouped under the head of the Walden Inversion; and at the present day we still await a solution of the problem"—rather disconcerting in the face of the work of Hughes and Ingold and of others on aliphatic substitution reactions during the past fifteen years. In fact, the reader soon realizes that the title is a misnomer and that practically none of the theoretical developments of the past twenty-five years are mentioned; and, although the sections on natural products are rather more up to date, little of the work of the past decade is described. Much that is already incorporated into text-books has yet to reach these volumes.

After chapters on carbohydrate constitutions and polysaccharides, attention is directed to the sesqui-, di- and tri-terpenes. The revision of the structure of cadinene in 1942 is not mentioned. The section on azulenes is rather unsatisfactory, particularly as these can scarcely be regarded as terpenes, while no indication is given of the presence in Nature of *bicyclo*[5 : 3 : 0]decenes, which are true sesquiterpenes; in contrast, eleven pages are devoted to the as yet uncertain structure of caryophyllene.

The now established structure for pimaric acid put forward in 1940 is rejected as "this alternative need not be considered", while it is not made clear that D-pimaric and L-pimaric acids are not enantiomorphs. In two chapters on alkaloids one might expect to find mention of the total synthesis of quinine (1943); but this is absent, and groups of alkaloids which have been actively investigated in recent years, for example, that based on the *cyclo*pentenophenanthrene skeleton, are ignored. The accounts of the anthocyanins, depsides and lignans are adequate, perhaps because little work has been done on these groups in recent years. Vol. 2 is concluded by a long chapter on "Some Theories of the Natural Synthesis of Vital Products" which appears to be substantially the views of the late Prof. Collie in 1907, for no account is taken of the syntheses of alkaloids under 'physiological conditions' by Schöpf during the 1930's, developments in our knowledge of enzymes and of the course of fermentations, or of the more recent views of Robinson. This chapter might well have been omitted from the present edition.

Vol. 3 opens with chapters on the bile acids and sterols, vitamins, hormones and cardiac aglycones, which give good accounts of the early work. The section on vitamin A brings the story up to 1932, although there is an appendix to this volume giving an indication of the synthetical developments in

recent years. The chapter on hormones contains no mention of the adrenal gland, let alone the steroidal hormones of this gland which have excited so much interest in recent years—the sole entry in the author index to Kendall refers to his early work on thyroxine, while that to Reichstein refers to work on vitamin C. Chapters on porphyrins and azaporphyrins are good, and the latter probably gives the first collected account of the phthalocyanines. The chapter on "Synthetic Polymers and Condensates", in opening with "These substances may be viscous liquids, hard and glass-like or amorphous rubber-like solids", gives little hint of the important uses fibrous polymers have found in the textile industry, and the existence of nylon is only mentioned in the last sentence in the chapter. The chapter on "Rubber" might be expected to give some account of the spectacular developments during the Second World War of synthetic rubbers, but instead gives a long account of the controversies over the polymerization of isoprene during the first decade of this century that led up to the synthetic product of the First World War. The brief chapter on "Some Deutero-Organic Compounds" might well have been expanded into an account of the labelling of atoms in general, in organic compounds, both by 'heavy' and by radioactive isotopes, and their use in elucidating the mechanisms of biological and non-biological chemical reactions. A chapter on "Some Cases of Isomerism in Cyclic Compounds" gives an account of the early work on the geometrical isomerism of fused ring systems, for the case of the decalins, but fails to bring out the fundamental connexion this has with optical isomerism and ignores the work of Hückel and of Linstead during the 1930's. A chapter entitled "The Diphenyl Problem" gives a good account of the early work that led up to the recognition of stereoisomerism due to restricted rotation as a general phenomenon. In "Some Aspects of Stereochemistry" the optical activity ascribed to nitroparaffin salts is now known to be non-existent. A chapter entitled "Other Cases of Abnormal Valency" deals with what would now be described as free radicals of long life, although the better-known triarylmethyl type is not described, and the existence of such radicals is not regarded as proved—"Once the conception of free radicals is admitted, the long-tried dogma of the quadrivalency of carbon comes into the scales for a final test". The opening sentence of the chapter entitled "Some Applications of Electronics to Organic Chemistry" clearly indicates that only the ideas of the first quarter of this century are considered, and that there have been developments since is only hinted at in a footnote. Vol. 3 concludes with chapters entitled "Structural Formulæ and their Failings" and "Some Unsolved Problems", which having served their purpose in earlier editions might well have been omitted from this edition.

It is not clear to the reviewer the purpose these volumes are intended to serve. The advance of organic chemistry is so rapid to-day that successive editions of a book of this type, particularly after an interval of nearly twenty years, would be expected to contain largely fresh topics, the material of the previous edition having by then been incorporated into text-books. Certainly the sections on theoretical topics are inadequate if not misleading; their deletion would give room to bring those on natural products up to date. Then, with the fuller detail thus given, these volumes would be of value to students in providing a bridge between the necessarily abbreviated accounts in general text-books and the terseness of the "Annual Reports" or the "Quarterly Reviews" of the Chemical Society.

In general, the author index does not discriminate between authors of the same surname, and the reviewer disclaims credit for most of the work ascribed to him.

S. H. HARPER

THE BOOK OF A BIRD-LOVER

In Praise of Birds

By Dr. Charles E. Raven. Pp. 206+17 plates. (London: George Allen and Unwin, Ltd., 1950.) 15s. net.

THE publication of this book, with its title of great charm, is something of a landmark, because it is a selection of some of the best bird papers which the gifted author has published during the past twenty-five years, enriched by some capital photographs. Among the illustrations, surely the most remarkable is that of a long-tailed drake in summer plumage, photographed in June, off Scourie, on the north-west coast of Scotland. To see, let alone to approach so near as to be able to photograph, a bird of the Arctic in June in British waters is unusual. That small drake must have been exceptionally tame, for it was obviously photographed at close range.

From Texel, with its wonderful population of wading birds, we follow the author northward, or more correctly north-west, to the rocky fastnesses of Foinne Bheinn and Arcuil (had the book been about animals, we might have been told about the legendary fork-tailed deer of Arcuil) in the remote Reay Forest, home of the golden eagle, of the greenshank and of the black-throated diver. (The black-throated diver did not nest until June this year, and, as almost always, lost her two eggs through her small nesting island being submerged by a sudden rise in the level of the loch, following on a day of heavy rain.) In the Reay Forest the author had an adventure with a golden eagle. It was only this summer that I was told by John Scobie, the hero of the tale (he spells his name, by the way, with only one 'b'), further details of that adventure, and he pointed out the rock on which the eagle nested on that occasion—the great bird does not now occupy that site, although it is still in the neighbourhood and was seen to carry to another eyrie a full-grown heron. The author (p. 199) asks why the common heron, obviously a marsh builder, should nest in trees. This has always puzzled me, and when on the Hebridean island of Colonsay I was shown a heron colony in the reeds of a loch, I thought how much more in keeping with their surroundings were the long-necked and long-legged birds there than on the tree tops where, on the mainland of Britain at all events, the species habitually nests.

When the author asks whether a bird may not perhaps have psychic sensitiveness, he finds himself in sympathy with the reviewer of his book, for it is unlikely that the human race should have the monopoly of psychic awareness.

"In Praise of Birds" is packed with good things. The style, as might be expected, is simple yet vivid; and the reader finds himself being held by one chapter after another, so that he lays aside the book with reluctance.

SETON GORDON

The Avian Egg

By Prof. Alexis L. Romanoff and Anastasia J. Romanoff. Pp. xiii+918. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 84*s*. net.

PROF. and Mrs. Romanoff have long been widely known as leading authorities on the biochemistry of the avian egg. In this exhaustive book they have brought together all that is known about the physiology of laying, the formation and structure of the egg, its physico-chemical properties, and its employment in the food industry. Although embryological considerations are excluded from the frame of reference chosen, the book will be indispensable for all who are concerned with the biochemistry of development and morphogenesis, since it unfolds the whole panorama of the very complex assembly of chemical substances which have to be made ready by the parent organisms for what one might call 'zero hour'.

The illustrations, many of which have been prepared especially for the work, are clear and excellent. No less than 2,600 references to original literature are assembled, and the index is adequate. Perhaps it is ungrateful to refer to them, but I do not like the somewhat sententious statements of the obvious which are dignified by italics as mottoes at the head of each of the chapters, nor do the symbolic charts (for example, that on p. 490) add anything helpful.

It seems a pity that, in the section on industrial uses, the authors did not include a chapter on the large-scale commercial incubation of eggs in the poultry industry, about which they probably know as much as anyone living; but doubtless they are reserving this for a companion volume of another thousand pages. In a second edition, it would be desirable either to expand the treatment of the place of the egg in folk-lore and philosophy, or else to delete the last few pages on "traditional uses" of eggs, which are trivial and form an anti-climax to an otherwise worthy work. JOSEPH NEEDHAM

Logical Positivism and Ethics

The Symposia read at the Joint Session of the Aristotelian Society and the Mind Association at Durham, July 9–11, 1948. (Aristotelian Society, Supplementary Vol. 22.) Pp. iv+215. (London: Harrison and Sons, Ltd., 1948.) 21*s*. net.

THESE essays are characteristic of the Symposia Reports issued from time to time by the Aristotelian Society. In this case they emanate from a joint session with the Mind Association. While not professing to settle anything, they are the result of philosophers thinking aloud among themselves. There are four parts dealing (in brief) with language, the emotive theory, logic, things and persons. In addition, there is an address on the theme of ethics without propositions. This reaches the broad conclusion that moral philosophy can be interpreted in a new way, though the 'risk' of making morality subjective is foreseen.

Prof. K. R. Popper produces the interesting remark that philosophical problems perhaps contain an empirical, as well as a logical, component; Mr. W. C. Kneale, however, is not convinced that this explains what is meant by logic, or how it can serve philosophy. Such are age-long questions, incapable of short answers. Prof. H. A. Hodges makes the valuable point that our present scientific outlook is probably inimical to a due respect for persons. Some there be that realize this, whereas 'other some' (to recapture a phrase used long ago at Athens) do not.

Dr. J. O. Wisdom is much concerned about the difficulties of 'taking ethics seriously'. But he throws out the intriguing suggestion that certain kinds of science, philosophy and art reveal what is hidden in the obvious. F. I. G. RAWLINS

The Science Masters' Book

Series 3, Part 1: Physics; being Experiments selected from the *School Science Review*. Editors: G. H. J. Adlam, S. R. Humby and G. N. Pingriff. Pp. xviii+318. (London: John Murray, 1950.) 15*s*. net.

ALL teachers of physics will give a hearty welcome to the new issue of this well-known and extremely useful book, which contains experiments selected from the *School Science Review*, covering the period 1937–45. More than two hundred experiments are included, and nearly half of these deal with electricity, though all branches of physics are generously represented. In their choice of contributions the editors have certainly moved with the times, for the increase in space given to electricity is accounted for mainly by wireless and the cathode ray oscillograph, an instrument which the editors rightly say will probably be much used in the future in schools. Then again, more space is taken up than in previous issues by notes on the construction of new apparatus. This development of making apparatus has probably been forced upon schools by the war-time dearth of apparatus, and it certainly has its advantages.

Apart from appreciating the help which the book gives to teachers and students, one is struck by the enthusiasm and interest of the contributors—some old, others new—in their jobs, and one feels that while we have men of this calibre the teaching of science in our schools is safe; however, one is tempted to ask, with a certain amount of misgiving, what about the future?

This is an excellent book which should be in the hands of all teachers of physics in all institutions where science is taught.

Rarer Metals

By J. de Ment and H. C. Dake. Pp. xv+345. (London: Temple Press, Ltd., 1949.) 25*s*. net.

THE original of this is an American book by the two authors named. This has been revised and extended by E. R. Roberts and R. C. Williams, who have added chapters on the rarer alkali metals, calcium, barium, rhenium and boron. In the American book practically only American sources of minerals were mentioned, more important sources elsewhere being completely ignored. This tendency has not been adequately rectified in the present edition, and it very seriously diminishes its value. In other cases where some additions have been made, only foreign materials have been mentioned, as in the case of the alloy steels for permanent magnets.

The book is essentially a compilation and is often uncritical; but it has a considerable value and gives a large amount of information not easily found elsewhere. The older German books, which such American books as this are supplanting, usually took account of work without preoccupation about its country of origin, and for that reason have a permanent value the newer books cannot achieve. J. R. P.

A BIOCHEMICAL APPROACH TO VIRUSES

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VIRUSES fall between two stools; but virus workers, instead of settling comfortably on the floor, try to maintain precarious positions on the stools. The stools are, of course, the chemical criteria suitable for the study of simple molecules such as vitamins and most hormones, and the biological criteria used with micro-organisms. Pragmatically the distinction is between the experimental methods that are characteristic of a biochemical, and of a purely biological, laboratory. We all agree that *Bact. coli* is an organism; but when it is being disintegrated to make an enzyme preparation or hydrolysed as a prelude to amino-acid analysis, it is being treated as a substance and, but for the preliminary agreement, might be looked on as a molecule. The position with viruses is similar. No one has demonstrated that some of them are 'substances' or 'macromolecules'. Indeed, such a thing is not susceptible of demonstration; it is not a statement about the viruses, but about the mental approach and technique of the research worker.

The use of biochemical methods in the study of viruses has contributed greatly to knowledge; but it has brought with it a danger of over-simplification. The application of some chemical methods to the study of a group of substances does not guarantee the amenability of these substances to all other chemical criteria. Thus, when one has produced a convincing mass of evidence that one of the smaller molecules has a certain constitution, it is generally agreed that this evidence excludes all other constitutions that are not equilibrium states of the first. But at the other end of the scale—on the other stool to use the original metaphor—this is not so. It is obvious that the zoological or botanical criteria for a species can often be satisfied by individuals covering a considerable range of size and shape and colouring, and this is also true of bacteria. If we rank biochemical and biological objects in order of size, it is not necessary to go so far along the size-scale as this to find variable structure associated with essentially the same activity. Distinguishable pepsins are elaborated by the same species, and even the same individual may make a mixture of antibodies as a result of the stimulus of what appears to be a single antigen. In many of these instances we know something of the factors that affect the properties, for example, environment or the route chosen for the injection of an antigen; but the fact remains that in this region of the size-scale an entity to which it is convenient to attach one label may not have unique properties. The viruses lie in the middle of this region; it is therefore probable that they too will be variable. The smaller viruses make an admirable prelude to biology; we see here a rudimentary form of the broad biological principle that the same final result can be achieved through the action of agents that are not chemically identical in the ideal sense.

The characteristic properties of viruses make any unequivocal demonstration of the nature of the infective particle difficult. In chemistry and in bacteriology the range of possibilities can be limited by synthesis or by the use of 'Koch's postulates'. Of the latter the most important is that the agent must be cultivated outside the host. Viruses cannot be cultivated in this way—perhaps, with the larger ones, for purely technical reasons that may be overcome; with the smaller ones the host is probably not just an alternative medium, as with most bacteria, but is an essential part of the virus-making mechanism. Cultivation in a medium that is not known to have any activities of its own if left uninoculated is an essential phase in the characterization of a disease-causing organism; it is the biological counterpart of synthesis in the chemical domain; it serves, like synthesis, to reduce enormously the risk of an unsuspected contaminant being the actual cause of the effects that are being studied. There are diseases where analogy is so strong, for example, malaria and the rusts of wheat, that it is unreasonable to insist on cultivation *in vitro* before accepting the ostensible cause as a real cause, but with the smaller viruses there is no such analogy. We have generally no means of knowing what proportion of the particles in a preparation is infective, and we cannot assume that the more infective of two preparations is the more nearly in its original state. Thus Bawden and Pirie[1] found that, by suitable treatment *in vitro*, the infectivity of preparations of one of the tobacco necrosis viruses can be greatly enhanced. They also found a characteristic nucleoprotein that did not appear to carry any infectivity at all. This may be analogous to the non-infective phase that Hoyle[2] has observed with influenza virus, and that Bauer[3] has postulated with other viruses.

There being no canons to guide research on the smaller viruses, the research worker is in the pleasant position of having to fall back on his intelligence, and keep all lines of evidence in mind without trying to use any particular one as a touchstone. It has been apparent since Bawden and Pirie showed that a series of plant virus preparations consisted predominantly of nucleoprotein that an aberration of nucleoprotein metabolism was the most characteristic feature of these plant virus infections. The earlier work of Schlesinger[4] and Craigie[5] on a bacterial virus and vaccinia had indeed already made this probable. The point has been generally accepted; it may be that it has been too readily accepted, and that a sufficiently sharp look-out is no longer being kept for preparations that act like viruses without containing significant amounts of nucleoprotein. Claude Bernard remarked: "Anatomy localises Physiology"—so also biochemistry limits biology. It shows quickly in which broad chemical field the immediately apprehensible aspects of the problem lie. Most people would agree that plants suffering from certain virus infections contain large amounts of nucleoproteins that are either absent from, or trivial constituents of, the uninfected plant. They would also agree that preparations consisting largely of this anomalous nucleoprotein can initiate a new infection. Is there any *a priori* reason for assuming that infection can lead to the production of only one anomalous nucleoprotein or that the ability to initiate infection in a new host is a property restricted to one ideal unique structure? Clearly there is not. Structures so similar that they are with difficulty distinguishable experimentally are likely, for this reason, to be confused by an organism, whether it is synthesizing the structure or responding to it. In the absence of evidence

it is only reasonable to assume that infection leads to the synthesis of a range of similar substances, and before the process of infection can be comprehended biochemically they must all be investigated. They may not all be able to initiate infection under all conditions, and there is no reason to assume that even the infective particles are of uniform composition. Only parts of a particle as large as a virus may have to make a steric fit with the host. The back of the particle may be so far from the synthesizing surface that it will only have to meet general mass and charge specifications. Small molecules do not have backs; the disposition of mass and charge in any part of the molecule is perceptible at a surface on which it is adsorbed. The observed specificity of structure needed for drug or hormone action does not therefore give any reason for assuming that there is an equal specificity for virus action.

Analytical techniques have not yet developed so far as to make it profitable to look for variations in the composition of viruses. Their sizes, however, have been extensively studied, and the results with tobacco mosaic virus illustrate clearly the difficulties encountered. The original length proposed for the particles in tobacco mosaic virus preparations was 1400–180 mμ[6]. This size-range was deduced from the properties of purified solutions, and emphasis was laid on the fact that the processes of purification so greatly enhanced those properties of a tobacco mosaic virus solution, generally attributed to the rod-like nature of its particles, that it was reasonable to assume that there had been linear aggregation. In several later articles this has been re-emphasized[7,8,9,10]. By working quickly and by avoiding treatments known to cause aggregation, preparations have been made[11] that are much less aggregated but that can be aggregated by exposure to many agents, including the sap from normal or infected leaves. A series of preparations was made by ultracentrifugal fractionation, each of which consisted predominantly of an anomalous nucleoprotein which could aggregate to give material similar in its physical and serological properties to tobacco mosaic virus preparations made by the usual dilatory methods. These fractions differed in infectivity; on electromicrograms of the more infective fractions, Crook and Sheffield[12] found a larger proportion of particles approximately 280 mμ long than in those fractions carrying less infectivity. But fractions containing few rods of this length carried infectivity, and this was not increased when they underwent aggregation. Many interpretations of these phenomena are possible. If there were any reason to assume that infectivity is a property confined uniquely to one type of particle, it would be reasonable to choose 280 mμ as its approximate length and then to invoke activating and inhibiting powers in the shorter particles to explain the infectivity of preparations containing few rods of this length and the absence of an increase in infectivity when the proportion of 280 mμ material is increased by aggregation. In the light of the argument set out earlier in this article, it seems easier not to make the initial, improbable, assumption.

The recognition by Crook and Sheffield[12] of 280-mμ rods in some preparations protected so far as possible from aggregation, and the corollary that these rods probably also exist in the infected leaf, gains support from the evidence that Wilkins *et al.*[13] have given that this is the length of the particles from which the crystals often found in hair cells on infected tobacco leaves are made up. Unfortunately, the information that can be got by their technique sheds no light on the questions over which there is any uncertainty: What proportion of the anomalous nucleoprotein in the tobacco mosaic virus infected plant is in each state of aggregation, and how is the infectivity distributed between these different states? The composition of these intracellular crystals is still uncertain. There is no reason to doubt that they contain nucleoprotein similar to or identical with the main component of a tobacco mosaic virus preparation, but they can scarcely be made up exclusively of this, because it is soluble at much greater concentrations than can reasonably be postulated in the hair cells. Tobacco mosaic virus preparations do, however, form paracrystalline complexes with a range of substances, some of which are components of sap[14,15]. It seems probable that the intracellular crystals are of this type, and that they can no more properly be called crystals of virus than salt crystals can be called crystals of sodium. Their properties are presumably mainly dictated by the major component, but the nature of the minor component is both a matter of interest and of importance. It is of especial importance because in a heterogeneous nucleoprotein mixture, such as is postulated, it is likely that certain components will be precipitated preferentially. The study of crystals in hair cells is of value, and Wilkins *et al.* describe several phenomena of interest to the microscopist and crystallographer; but an examination of the state of part of the nucleoprotein in structures that make up less than 0·1 per cent of the weight of the leaf gives hints rather than evidence about the properties of the remainder of the nucleoprotein in the other 99·9 per cent of the leaf.

If it is agreed that an important feature of infection with tobacco mosaic virus is a gross derangement of nucleoprotein metabolism, it must follow that in gaining an understanding of the mechanism of infection all the anomalous nucleoprotein must be studied. Attention must not arbitrarily be restricted to one size and shape of particle out of the range that is indisputably present in the infected plant. Some of this nucleoprotein may be wholly irrelevant, some may be breakdown products of the virus, some may be component pieces of virus awaiting assembly, in the manner that Luria and Dulbecco[16] have postulated for a bacterial virus, and some may be the virus itself. But the term 'virus' should be used with circumspection, for we have no means of defining criteria for its rigorous use. Its simple unqualified use, especially in experiments like those of Wilkins *et al.* in which no infectivity measurements have been made, is to be deplored. It is apt to lead the reader astray, and it is possible that it may lead the authors astray also.

[1] Bawden, F. C., and Pirie, N. W., *J. Gen. Microbiol.*, **4**, 464 (1950).
[2] Hoyle, L., *Brit. J. Exp. Path.*, **29**, 390 (1948).
[3] Bauer, D. J., *Nature*, **164**, 767 (1949).
[4] Schlesinger, M., *Nature*, **138**, 508 (1936).
[5] Craigie, J., *Brit. J. Exp. Path.*, **13**, 259 (1932).
[6] Bawden, F. C., and Pirie, N. W., *Proc. Roy. Soc.*, B, **123**, 274 (1937).
[7] Pirie, N. W., *Biol. Rev.*, **15**, 377 (1940).
[8] Pirie, N. W., **Adv. in Enzymology**, **5**, 1 (1945).
[9] Pirie, N. W., **Ann. Rev. Biochem.**, **15**, 573 (1946).
[10] Pirie, N. W., *Exp. Cell. Res.* Supp. **1**, 183 (1949).
[11] Bawden, F. C., and Pirie, N. W., *Brit. J. Exp. Path.*, **26**, 294 (1945).
[12] Crook, E. M., and Sheffield, F. M. L., *Brit. J. Exp. Path.*, **27**, 328 (1946).
[13] Wilkins, M. H. F., Stokes, A. R., Seeds, W. E., and Oster, G., *Nature*, **166**, 127 (1950).
[14] Best, R. J., *Nature*, **145**, 627 (1940).
[15] Bawden, F. C., and Pirie, N. W., *Biochem. J.*, **34**, 1278 (1940).
[16] Luria, S. E., and Dulbecco, R., *Genetics*, **34**, 93 (1949).

FOLDING AND UNFOLDING OF PROTEIN MOLECULES IN RELATION TO CYTOPLASMIC STREAMING, AMŒBOID MOVEMENT AND OSMOTIC WORK

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IN this article evidence is presented that, in the amœba, protein molecules fold up at one end of the cell and unfold at the other, and that this results in cytoplasmic streaming and in osmotic work.

Amœboid movement is of considerable interest, since it is not only a feature of a group of Protozoa but is also a fairly general property of cells when they are unconfined by neighbouring cells or rigid envelopes. Further interest is added because it appears that, in mitosis, the division of the cytoplasm just after the division of the nucleus may be the result of two oppositely directed amœboid movements within the parent cell.

Various theories have been proposed[1,2] to account for amœboid movement: local differences in surface tension; a rhythmic contraction of the cell membrane; contraction of the cytoplasm due to gelation; a difference of *p*H, or of water content, between the front and rear of the cell, and so on. While there may be a germ of truth in some of these, they either conflict with experimental facts at some point or are quantitatively inadequate to account for the amount of movement that takes place.

It is now generally agreed that amœboid movement is due to the contraction of the cortical gel at the rear portion of the cell. After contracting, the gel liquefies and the resulting sol is squeezed forward along the central channel of the cell to form more gel on the walls of the advancing pseudopod.

Fig. 1 shows the same cell photographed at short intervals of time in three successive positions. Two pseudopodia at the rear of the cell are fixed points of reference, remaining stationary on the slide. It can be seen that the membrane on the left of them becomes greatly reduced in area in half a minute. The membrane must be dissolving, for otherwise the cell would soon become filled with it. The part that is dissolving (tail) has a wrinkled appearance rather like the appearance of a monomolecular layer of protein or lipo-protein seen under the microscope after it has been collapsed by compressing it on a Langmuir trough. Solution of the membrane is probably due to the folding up of its protein molecules into the globular form[3] as a result of two-dimensional compression arising from the contraction of the cortical gel attached to it.

The tail is a relatively permanent part of the cell, in contrast with the advancing pseudopod and the adventitious lateral pseudopodia. The membrane at the tail is much more firmly attached to the cytoplasm than at any other part of the cell. This can be demonstrated by a wide variety of reagents. When amœbæ in a hanging drop are exposed to the vapour of practically any volatile fat-soluble substance, such as chloroform, ether, benzene, hexane, phenol, ethanol, and, notably, osmic acid, the membrane lifts away from the cytoplasm by about a quarter of the cell's diameter, except at the tail, where it remains attached.

The gel in the tail liquefies after it has contracted to about a quarter of its original length. It appears as though it contracts as a result of some substance secreted on to it from a body in the tail—a 'tail organiser'. As the tail advances, it liquefies each part of the cortical gel in turn. The tail is pulled forward continuously by the contraction of the cortical gel attached to it.

Working Hypothesis

It is likely that the protein molecules in the liquid part of the cytoplasm must be folded up, since almost all known proteins gel when unfolded (for example, by heating), when in as high a concentration as they occur in cells (that is, about 10–20 per cent). The protein molecules in the gel would be unfolded in order to form an interlocking network of fibres. The change from gel into sol as a result of the folding-up of the molecules would thus cause a contraction during the first part of this process, as shown in Fig. 2.

A diagrammatic representation of the protein molecules in the amœba would be as shown in Fig. 3.

The sizes of protein molecules make it feasible to handle them diagrammatically as shown here; for the length of an amœba (0·3 mm. for *A. discoides*) could be spanned by the unfolded polypeptide chain of a protein molecule of molecular weight 100,000,000, and the cortical gel would correspond to the thickness of about 10,000 wet protein monomolecular layers.

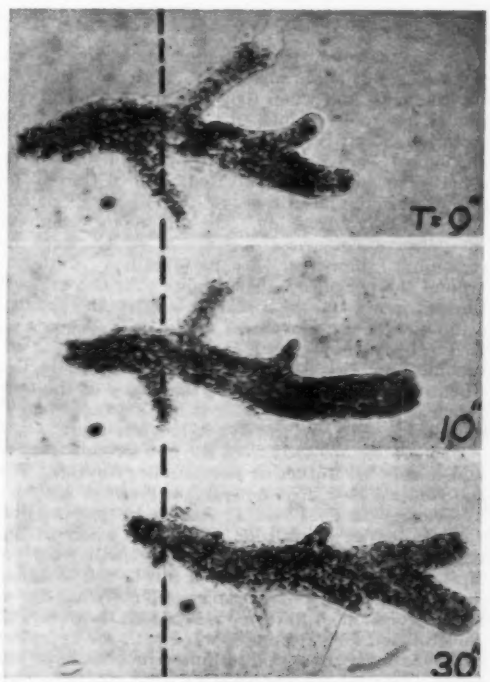

Fig. 1. *Amœba discoides*, photographed in three successive positions, showing contraction of cortical gel and cell membrane in the tail region

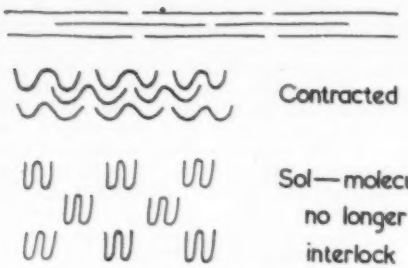

Fig. 2. Diagrammatic representation of the folding-up of protein polypeptide chains in the protoplasm

Testing of Model

The model postulated for the cell predicts the existence of certain phenomena :

(1) *Osmotic work, that is, the concentration of material against a concentration gradient.* When protein molecules are unfolded, they have more surface area available for the adsorption of other molecules than when they are folded up, since the side-chains used to hold one part of the polypeptide chain to another part in the folded globular molecule become free and turn towards the solution and can then adsorb other substances. In accordance with this, it was found that egg albumen adsorbed eight times as much dye when unfolded as a monolayer as when in a globular form in solution; similarly, Oster[4] has found that tobacco mosaic virus increased its uptake of dye 300 times when denatured. This difference between ovalbumin and the virus is to be expected, because larger molecules have a higher proportion of the side-chains buried within the molecule.

In the amœba, the unfolded molecules in the cortical gel should adsorb the material from the environment, and when they fold up in the tail they should desorb it. Thus, in time, a large amount of material should be released into the tail.

Amœbæ were placed in a dilute (0·01–0·001 per cent) solution of Neutral Red, and within a few minutes accumulated the dye in their tails, but only when actively streaming. The advancing pseudopod was always colourless. Amœbæ which were not streaming, however, became stained uniformly around the periphery. This shows that the colour in the tail is not due to a stainable body there, but is a function of the movement of the cell. When a cell died or became cytolysed, the whole of the cytoplasm became quickly stained, much more intensely than when alive. This shows that the whole of the cytoplasm is stainable, and that it has a mechanism for releasing itself from the dye it has taken up.

The protein released from the dye streams forward and takes part in further accumulatory cycles. Why the Neutral Red does not stream forward with it is not clear. It does not appear to be trapped in a vacuole, as in plant cells (*v.i.*), but when in high enough concentration causes some small local precipitation of protoplasm, which can be felt as a hard lump with the microdissecting needle. When the cell is in a solution of lower concentration, however, the Neutral Red does stream forward with the cytoplasm and eventually appears distributed in what have been called "neutral red vacuoles"[5].

(2) *Contraction induced by adenosine triphosphate.* The changes occurring in the amœba's tail are paralleled by the action of adenosine triphosphate on the actomyosin gel. Thus, addition of adenosine triphosphate causes the liquefaction of the actomyosin gel, and the contraction of an actomyosin fibre[6]. Accordingly, a 1–3 per cent solution of adenosine triphosphate, adjusted to *p*H 7 with sodium hydroxide, was injected into the amœba, with the following result: (1) when injected into the tail, the speed of streaming of the amœba and the area of the wrinkled tail region was increased several times; (2) when injected into the advancing pseudopod, the streaming of the amœba reversed; (3) when injected into the centre of the amœba, it became crinkled all over and developed a kind of rigor. With larger amounts the cell rapidly put out pseudopodia and withdrew them all over its surface. This was reminiscent of the 'bubbling' which occurs in amœbæ and in tissue culture cells during the final stages of nuclear division. Since prodding the cell causes some disturbance, control injections were carried out with distilled water and various salt solutions, but without effects comparable with those of adenosine triphosphate.

The effect of adenosine triphosphate lasted less than a minute and the substance could be injected repeatedly to produce the same effect. In contrast with distilled water and physiological salt solution, which tended to be pinched off as a bubble, adenosine triphosphate mixed with the cytoplasm and was remarkably innocuous.

(3) *Liquefaction by heparin.* In the advancing pseudopod the cytoplasm clots on the freshly formed membrane to form new cortical gel. Injection of the anticoagulant, heparin, was found to prevent this process. The cytoplasm liquefied at the site of injection of a 0·1 per cent solution, and the pseudopod extended from that spot was spherical, not cylindrical, indicating the absence of cortical gel. The whole of the cell poured out into this spherical pseudopod. Injection of heparin thus acts as an additional control experiment.

Summarizing, adenosine triphosphate and heparin have opposite effects: adenosine triphosphate causes

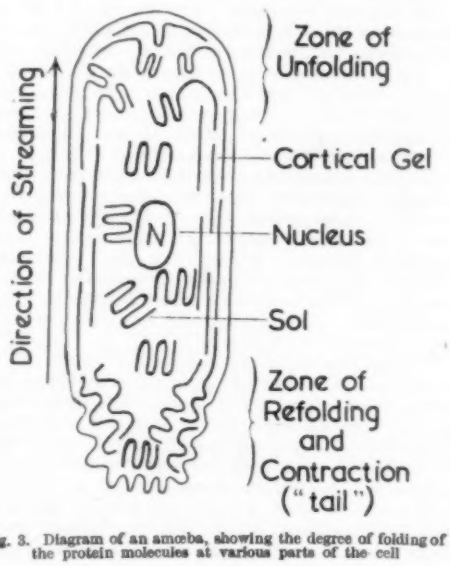

Fig. 3. Diagram of an amœba, showing the degree of folding of the protein molecules at various parts of the cell

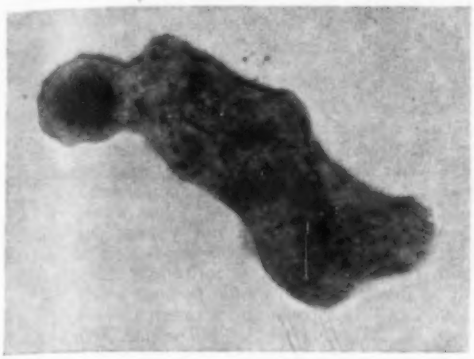

Fig. 4. *Amœba discoides*, after streaming for 15 minutes in 0·003 per cent Neutral Red solution, showing accumulated dye in the tail (left-hand top)

the motion of the cytoplasm away from the site of injection, and heparin causes motion towards it.

Discussion

It is tempting to speculate about the chemical details of this contraction process. One might imagine an enzyme in the tail (the 'tail organiser') producing a substance like adenosine triphosphate from a precursor widely distributed in the cytoplasm. The 'tail organiser' gradually becomes exhausted and the cell rounds up prior to division. Cytoplasmic movement is not conspicuous again until nuclear division takes place. The 'resting' nucleus has meanwhile made two 'tail organisers', and throws these out when it divides, releasing at first large quantities of adenosine triphosphate-like substance. This causes 'bubbling' of the cell and eventually contraction of the cortical gel in the cleavage furrow. The cytoplasm is 'revitalized'[7], and the two nascent daughter cells, now having tail organisers, move apart by ordinary amœboid movement, at first as parts of the parent cell, and later as separate individuals. In support of this is the fact, revealed by speeded-up microcinematography (of fibroblasts in tissue-culture, as well as of amœbæ), that the tails of the daughter cells originate from the cleavage furrow of the parent cell.

The advancing stream of cytoplasm from the tail flows over the nucleus, which maintains a central position. The nucleus increases in size during cytoplasmic streaming. It appears to alter the plasmasol in such a way that it can gel again on the walls of the advancing pseudopod. Enucleation of the amœbæ causes a temporary bubbling, and afterwards the cell streams only feebly and intermittently[8,9]. When the nucleus is put back the cell resumes continuous and vigorous streaming within a short period[9,10]. Thus, a function of the nucleus—apart from the part it plays in heredity—appears to be that of a depolarizer, in the same way as the depolarizer in the electric cell (the current is weak and intermittent without the manganese dioxide or other oxidizing agent, but strong and continuous with it). The nucleus may collect the adenosine triphosphate-like substance and its breakdown products secreted by the tail (hence the 'bubbling' of the enucleated amœba), accumulating this material and resynthesizing from it two tail organisers which it ejects at nuclear division. It may be that the division of the nucleus is triggered-off by the accumulation within it of more than a critical concentration of these adenosine triphosphate breakdown products. This is supported by Schaeffer's[11] observation that amœbæ divided on an average every two days, but if one of the two daughter cells resulting from a particular division divided earlier than this, then the other usually divided later. This suggests that some substance connected with the triggering of mitosis is occasionally divided unequally. However, it is unwise to take this speculation too far without chemical data on the distribution of adenosine triphosphate-like substances between nucleus and cytoplasm at various stages from one division to the next.

Some Generalizations

The question arises whether protein-folding is a special arrangement met only in the amœba or a general phenomenon occurring in other cells. It certainly appears that the same process goes on in other types of cells although in a different geometrical guise. For example, in the root hairs of plants there is a vacuole near the tip over which cytoplasm streams, bodily reversing its direction about every five minutes. Cytoplasm and vacuolar membrane, being in contact, move practically together so that the membrane moves away from one end of the vacuole and would accumulate at the other, unless it dissolved there. Presumably the protein molecules are folding up at the end of the vacuole towards which the cytoplasm streams. In support of this it was found that Neutral Red accumulated there when various roots were placed in a solution of the dye. Then, on reversal of streaming, it accumulated at the other end.

Again, in the septate hyphæ of the mould *Neurospora*, Neutral Red accumulated at the end of each cell, as in amœbæ.

Speeded-up cinematography reveals that fibroblasts in tissue culture are like amœbæ in which the various contractile elements have been liberated from the cortical gel and have gained a measure of independence so that they are not all forced to contract at once. It might be expected that each contractile element in the cell would act as an independent accumulatory mechanism, and in support of this it was found that chick fibroblasts in Neutral Red solution accumulated the dye within half an hour, in three or four diffuse clouds at various parts of the cell.

The protein molecule is unique in that its chemical and physical properties are greatly altered by changes in the degree of folding of the polypeptide chain. That this property might be exploited in living cells and be the basis of many vital phenomena has been suggested, especially by Astbury[12] and Szent-Györgi[6]. The reversible conversion of a mechanical into a chemical effect, by pulling a protein molecule undone so as to expose new side-chains to the solution, might conceivably be the basis of protoplasmic movement in general; of secretion, especially where, as in renal and gastric secretion, osmotic work is a major feature; and even of electrical effects across membranes, as in the electric organs of fishes, muscular contraction and nervous conduction where any folding of protein in the surface would be expected to change the potential across it.

A more detailed report will be published elsewhere.

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[1] De Bruyn, P. P. H., *Quart. Rev. Biol.*, **22**, 1 (1947).
[2] Holtfreter, J., Proc. 6th Internat. Congr. Exp. Cytol., Stockholm, 497 (1947).
[3] Elkes, J. J., Frazer, A. C., Schulman, J. H., and Stewart, H. C., *Proc. Roy. Soc.*, A, **184**, 102 (1945). Langmuir, I., and Schaeffer, V. J., *Chem. Revs.*, **24**, 181 (1939). Langmuir, I., and Waugh, D. F., *J. Amer. Chem. Soc.*, **62**, 2771 (1940). Neurath, H., Greenstein, J. P., Putnan, P. W., and Erickson, J. O., *Chem. Rev.*, **34**, 157 (1944). Davson, H., and Danielli, J. F., "The Permeability of Natural Membranes", 60 (Camb. Univ. Press, 1943).
[4] Oster, G., and Grimsson, H., *Archiv. Biochem.*, **24**, 119 (1949).
[5] Hopkins, D. L., *Biodynamica*, **2**, 1 (1938). Carrel, A., and Ebeling, A. H., *J. Exp. Med.*, **44**, 261 (1926).
[6] Szent-Györgi, A., "Chemistry of Muscular Contraction" (Acad. Press Inc., N.Y., 1947).
[7] Calkin, G., and Summers, F., "Protozoa in Biological Research", 18 (Columbia Univ. Press, N.Y., 1941).
[8] Clark, A. M., *Aust. J. Exp. Biol. Med. Sci.*, **20**, 241 (1942).
[9] Commandon, J., and de Fonbrune, P., *C.R. Soc. Biol.*, **130**, 740, 744 (1939).
[10] Lorch, I. J., and Danielli, J. F., *Nature*, **166**, 329 (1950).
[11] Schaeffer, A. A., *Arch. f. Protistenk.*, **37**, 204 (1917).
[12] Astbury, W. T., *Nature*, **157**, 121 (1946).

PRESENTATION OF TECHNICAL INFORMATION

THE discussion at Birmingham, on September 1, arranged jointly by Sections A (Mathematics and Physics), G (Engineering) and J (Psychology) of the British Association, on the presentation of technical information attracted an audience in which other sections, notably chemistry, were also well represented. Prof. R. O. Kapp, who opened the discussion, pointed out that a large and growing portion of the time of a scientific worker or engineer is now concerned with the written and spoken word, and the presentation of technical information is no longer of subordinate importance but dominates many of our activities. This is an inevitable consequence of the development of our delicately balanced civilization, which depends more and more on collaboration within an ever-widening circle. This collaboration, he said, can only be achieved with the help of an interchange of information, much of which is technical, and the written and spoken word have now become important tools with which scientific men and engineers have to work. From this point of view, Prof. Kapp developed his plea for more care and thought in the art of exposition, both to avoid the waste of time of the reader, and to avoid the possibility of misunderstanding or misinterpretation leading to wrong action. Equally, he observed, if a report is not adapted to its purpose, confusing or difficult to follow, ambiguous, or requiring excessive time for perusal, it may easily lead to the report being ignored, with the result that some desirable action is not taken. Reports, he insisted, are an essential part of the machinery of an organisation, and the efficient working of an organisation depends on their quality as much as it does on the quality of the tangible machines.

Prof. Kapp suggested that in our failure to appreciate the importance of the proper technique in the presentation of technical information, we have lapsed from early standards. The writings of eighteenth-century scientific men show many examples of good exposition, and it was only as the nineteenth century advanced that the increasing preoccupation of scientific men with their own specialized field made most of them tend to become less aware of other people. Prof. Kapp did not pursue the question whether the art of technical exposition could fairly claim to be recognized as an intellectual discipline; but he urged that we should at least study the technique in all its aspects and attempt to perfect and to teach it. Whether we are concerned with scientific books and papers to learned societies, with the spoken word such as the lecture, with the technical report, with that voluminous but valuable technical literature, often unjustly disparaged, which every manufacturer has to issue to ensure that his customers make proper use of his products, or with the spoken word in conference and committee, full regard must be had to the psychological factor if exposition is to be appropriate and effective.

This need for the good expositor to be vividly aware of other people was also illustrated by Prof. Kapp in reference to typography, and the choice of the most appropriate method for conveying technical information pictorially; but he pointed out that if illustrative material is not good, or if it is not used on a suitable occasion or on a suitable subject, it is ineffective, and by wasting time and diverting attention from the subject under discussion may even be misleading. While linguistics is the aspect of exposition most commonly referred to, Prof. Kapp believes that mastery of the English language is less important than either logic or awareness of the person addressed. The expositor who would express himself with precision must think clearly not only about the theme under discussion but also about the person to whom the information is being conveyed. The art of exposition demands more than anything else an understanding of the work done by the person to whom technical information is being presented.

This factor did not receive much discussion in the following papers, though it was well illustrated in Mr. L. Bainbridge-Bell's lively exposition of the need for clearer circuit diagrams. Those who were not electrical engineers followed his handling of a highly technical theme with obvious enjoyment and understanding, and his question to the visitor who remarked that it is nice sometimes to puzzle over a diagram, "When you ask your boss for a rise, do you put it in as an acrostic?", well illustrates the practical character of his suggestions and principles for clearer presentation.

Miss M. D. Vernon's paper, giving a psychologist's view, said less than might have been expected about that aspect. It presented the results of an inquiry into the effectiveness of the use of graphical data, which emphasized the hiatus between the ability of the scientific worker and that of school children and the general public to understand numerical data presented to them in the form of diagrams, graphs or tables of figures. In general, Miss Vernon's inquiry suggested that the reader will not profit much from the inclusion of such data with a written text unless he or she has had sufficient training and experience in the use of such graphical forms, and that they

must be simple and must not give information differing in any way from that presented in the text. Furthermore, the general argument or thesis must be clearly stated in the text, because the reader will be unlikely to work it out independently from the graphical and numerical data alone.

Miss Vernon's paper thus supported Prof. Kapp's plea for further study on the value of particular methods of illustrative material. Mr. Geoffrey Parr's paper on the relations between the technical author and his publisher was concerned in part with ways in which the average delay of four to six months in the publication of articles and fifteen to twenty months in the publication of books could be minimized by greater attention to details on the part of authors. In the average book of 80,000 words, the actual text or manuscript forms only 55–75 per cent of the whole book. Drawings and photographs may occupy 15–35 per cent, and preliminary matter, bibliographies, glossaries, and the index account for the remainder. The illustrations and the comparatively small remainder are the usual causes of delay in production, and Mr. Parr gave a check list of details liable to be overlooked which the author should verify as completed before submitting a manuscript.

Such a check list would include: all text pages numbered consecutively; figures and photographs numbered consecutively; suitable descriptions for each figure; permission to reproduce each borrowed figure; acknowledgments in preface; table of contents; list of plates (if not in text-matter); preface; foreword; bibliography checked and complete; references in text complete; references back in text made accurately; appendixes, if any; glossary; list of symbols (and examination of text to see that all symbols agree with list); and mathematics clearly set out. If all these are checked and complete, the delay in production caused by referring back to the author will be considerably lessened. Mr. Parr said that, in his experience, many of these items are regularly overlooked, and that among six hundred manuscripts read and checked during the past ten years, only five authors had submitted manuscripts in such a form that they could be sent to the printer without delay or query. He said that it is rare to receive a manuscript which does not involve lengthy correspondence and waiting time while the missing information is produced.

In the remaining paper, Mr. F. M. Colebrook dealt with the special features of the writing of scientific and technical papers which arise when the author is a member of the paid staff of a scientific organisation—more particularly of a national, or at least not a commercial, organisation. Mr. Colebrook drew mainly on his own experience in the National Physical Laboratory, and urged that the first distinctive feature is that the writing of papers by the staff of such organisations is, in general, a public duty, since such papers are sometimes the main return to the public for the public money spent. It followed that it is an obligation on the senior officers of such organisations to see that the papers are written, and are written well. The practical problem is very often to persuade the reluctant authors, but besides this it is necessary for the organisation to assist and advise its potential authors. This is bound up with the second distinctive feature, that the good name and reputation of the organisation as a whole are involved in the papers that are written by its individual members. Mr. Colebrook recognized that this gave the organisation the right, if not the obligation, to foster and insist on a high standard of presentation and also the right to control publication within certain limits. This he regarded as a proper and useful discipline rather than any real infringement of freedom of expression; but he thought that the balance of argument is heavily against anonymity, and that any departure from the principle that the names appearing on papers should be those of the real authors is a breach of professional ethics. Mr. Colebrook took the view that the reading of the paper in manuscript by one or more colleagues is an aid to the maintenance of high standards of presentation, and that organisations could also assist the early and effective dissemination of information.

Apart from these points, however, Mr. Colebrook's paper, like the other papers and contributions to the discussion, was stronger at diagnosis than in suggestions for action. Prof. Kapp, indeed, suggested that study of the factors on which receptivity depends, the laws which govern the association of ideas and the way memory works, would be useful, as well as the investigation of the criteria for distinguishing between good and bad methods of pictorial presentation; but no one went nearer to the root of the immediate trouble than the overseas student who pleaded that some systematic instruction in the presentation of reports and scientific papers should be given in the universities. With that and effective teaching of English usage and composition in the schools, there should be little need for a periodical on the subject or for further additions to a reasonably adequate literature, at least so far as the linguistic aspect is concerned.

NEWS and VIEWS

New South Wales University of Technology

DURING the past year, considerable attention has been paid to the encouragement and organisation of research work within the New South Wales University of Technology. Facilities for carrying out investigations have been established, including the appointment of research workers and technical officers with sufficient time free from teaching commitments to enable them to assist the professors and lecturing staff in designing equipment, in setting up apparatus, in carrying out tests and ensuring continuity of work. In addition to the generous Nuffield grant of £25,000 for the Nuffield research professorship in mechanical engineering, the work of the University has been given further tangible recognition by the Commonwealth Universities Commission, which has allocated £10,000 for carrying out research work in the University in 1950, and a similar amount for 1951. The Joint Coal Board has given £11,000 for research into mining problems. Projects being undertaken in the fields of applied chemistry and chemical engineering are prominent in the list, and in certain cases are being carried out in conjunction

with the Commonwealth Scientific and Industrial Research Organization. The full range includes also mechanical, civil and electrical engineering projects.

Prof. R. M. Hartwell

Mr. R. M. Hartwell has been appointed to the foundation chair in the Faculty of the Humanities in the University; the title of the chair will be that of economic history. Mr. Hartwell is completing requirements for the degree of doctor of philosophy in the University of Oxford under a National University Fellowship, and he has also been elected to a fellowship of Nuffield College. Mr. Hartwell, who is twenty-nine years of age, was a foundation student of the Armidale University College and took his M.A. degree with first-class honours and the University medal in economics at the University of Sydney as a teaching fellow in the Faculty of Economics. He has carried out research on the economic history of both Australia and Tasmania, and on the development of the wool manufacturing trade of the British Commonwealth. He is at present visiting leading universities and technological institutions in Europe and in America. His present appointment at Sydney is in conformity with the policy adopted by the governing council of the New South Wales University of Technology of including the humanities as compulsory subjects in its degree courses from their inception.

Bicentenary of A. G. Werner (1750–1817)

Abraham Gottlob Werner, the eminent German geologist, came of a family long engaged in the mining industry, and was born at Wehrau in Saxony on September 25, 1750. He was educated at a school in Silesia and then was employed in a foundry under his father, who taught him to recognize the various minerals. At the age of eighteen, a visit to Freiburg led to his studying there and at Leipzig, and in 1774 he published his first paper, "The External Characteristic Features of Fossils". In 1775 he was appointed inspector of collections and teacher in the Mining School at Freiburg. His teaching was always fresh and vigorous, and in a few years Freiburg became the great centre for the study of mineralogy and structural geology. Werner published but little, and his widespread influence was due to the succession of eminent students who worked under him: among these were Humboldt, Brucchi, von Buch, Reuss, Brochant de Villiers, Giesecke, Hailstone, Greenhaugh, Freiesleben, Charpentier and many others. In 1787 Werner published a treatise on the classification of rocks, and in 1791 he wrote a work on his view of the formation of veins. The Wernerian doctrine taught "that all the rocks of the crust like the earth's body itself have taken origin from aqueous solutions, either as chemical or as mechanical precipitates, while volcanic lavas and scoriæ represented rock material that had been so precipitated but had subsequently been melted and ejected". The controversy between the Neptunists and Vulcanists waged for many years, especially in Germany, and much valuable time was lost in the discussions that followed. Werner was a born teacher; he possessed a marvellous memory and quick powers of observation, and he never relaxed his reading and research. He visited Paris in 1802 and was elected a foreign associate of the Academy of Sciences. After holding his post in the Mining School at Freiburg for more than forty years, Werner died at Dresden, unmarried, on June 30, 1817.

Chemistry and the Press: Panel of Expert Writers

The Chemical Council, which represents the Royal Institute of Chemistry, the Chemical Society and the Society of Chemical Industry, has recently set up a panel of chemists who are qualified both as chemists and as writers, and also who are willing to undertake the writing of occasional articles for the weekly periodicals and magazines and the daily Press. In selecting this panel, due regard has been paid not only to the members' qualifications in chemistry, particularly in specified fields of work, but also to their ability to write for the non-scientific reader. The council of the Royal Institute of Chemistry has agreed to act as a centre for directing inquiries from editors to appropriate experts on the panel; but the Chemical Council insists that neither the contributors of articles nor the officers of the Royal Institute of Chemistry should be troubled by requests for information over the telephone or asked to supply quick answers to current inquiries, since this method involves risk of the information being incorrectly reported. The Council also considers that there should be some assurance from editors that the articles thus prepared will not be treated in a way that distorts the meaning or balance of the presentation, and it suggests that the scientific contributor should be given the assurance that he will see a proof of the article before publication so that he may have an opportunity of amending or rejecting. The panel has been drawn up mainly at the suggestion, and for the convenience, of representatives of the Press; but no claim is made that the list contains the names of all those qualified to write suitable articles for the lay Press, nor does the Chemical Council claim to be the sole source of information as to who is most competent to write such articles. As a general guide to editors, the list of writers is classified under six main headings: the science of chemistry; chemistry in agriculture; chemistry in relation to foods and nutrition; chemistry in relation to medicine; chemistry and the law; and chemistry in industry.

Dunlop Research Centre in Negri Sembilan, Malaya

At a time of political stress in Malaya, it is a noteworthy achievement that the Dunlop Research Centre, situated in Negri Sembilan, on the Regent Estate of Dunlop Malayan Estates, Ltd., should have been opened last June. It is to be hoped that, with improving conditions, it will form a nucleus leading to considerable new knowledge and technical achievement in the East. The main building contains two large air-conditioned laboratories, an office, a store, an air-conditioning plant, a large workshop, and three good flats for senior Asiatic staff. In the immediate vicinity are bungalows which provide accommodation for the director of research (Dr. F. J. Paton) and the technical staff. Since Dunlop Malayan Estates, Ltd., devotes almost all the capacity of its 80,000 acres to the production of rubber latex, its problems are to a large extent physico-chemical and colloid in character, and considerable attention is being given to the study of latex constitution and to treatments in Malaya that will make the latex more and more suitable for home-manufacturing processes. New methods of latex preservation other than the usual ammonia preservation are being actively investigated. Centrifuging is the chief method employed for concentrating latex, although, more recently, interesting electrodecantation methods have received close

attention. The Dunlop Estates carry a large proportion of clonal trees. Such trees give high yields, and their further development is a particular concern of the Research Centre, especially the relationship of latex quality, constitution and yield to the clonal strain. It is particularly opportune that the opening of the Research Centre in Malaya coincided with the opening of the Dunlop Research Centre in Birmingham (see *Nature*, July 8, p. 52). Many latex researches have necessarily to be carried out on the spot in the Far East; but the close liaison with the research staff in Great Britain and periodical interchange of staff afford a unique opportunity of correlating quality after shipment with initial treatment and of bringing consumer and producer problems into true technical perspective. The new Malayan Research Centre keeps in close touch with the Rubber Research Institute in Kuala Lumpur, and there is much friendly co-operation and rivalry with the technical groups of other producing companies in Malaya.

New Material on Benjamin Franklin

Besides the story of "Philosophical Hall" which has served as the home of the Society for 160 years, a recent issue of the *Proceedings of the American Philosophical Society* (**94**, No. 3; June 20, 1950) contains a considerable amount of hitherto unpublished information about Benjamin Franklin. Among the papers is one by Prof. Gilbert Chinard describing the Abbé Lefebure de la Roche's recollections of Franklin; this is accompanied by a photograph of a portrait of Franklin painted by an unknown artist and acquired by the American Philosophical Society from Paris a year ago. Prof. I. B. Cohen comments on the facsimile of a short pamphlet printed by Franklin to describe his observations on the transit of Mercury which occurred in 1753. Franklin's anticipation of modern psychological warfare is reported by Lynam H. Butterfield in an article which describes the successful plan adopted jointly by Jefferson and Franklin to cause desertions among the Hessian mercenaries who had been hired by George III to take part in the American Civil War. The way Franklin's fame and influence increased in Italy until it reached a peak in the last half of the nineteenth century is described by Prof. Antonio Pace, while Charles Coleman Sellers gives an illustrated account of the portraits of Franklin painted by C. W. Peak. Among other interesting articles in the *Proceedings* is a description of some American students of "that shining oracle of physic", Dr. William Cullen of Edinburgh, during the years 1755–66, and the story of the magnetic recording of American Indian languages.

Prehistory and the Humanities

The study of prehistory can be a pleasing intellectual hobby, dealing as it does with the origins and early cultures of mankind. But, while this is perhaps its main contribution to the present age there is, too, another more philosophical side to the picture. A realization of the great age not only of humanity but also of seemingly advanced cultures and their rise and fall does affect one's outlook on life. Our own times, seen against this vast background of antiquity, take on a new importance, or rather lack of importance. It is well, sometimes, for research workers in the field to stand back and look at the implications of their work. Dr. C. van Riet Lowe is clearly doing this in his article entitled "Prehistory and the Humanities" (*S. African J. Sci.*, **47**, 3; 1950), and finding something very interesting. One result of his studies which has impressed him has been the fact of the unity of the human race and the importance of the teaching of prehistory for demonstrating this fact. Dr. Lowe feels that an appreciation of spiritual issues is vital nowadays in our crumbling world, and that the churches would do well to realize and utilize the results obtained by what is already a long period of prehistoric research.

Plant Viruses and Virus Diseases

In the Masters Memorial Lectures of the Royal Horticultural Society for 1949, delivered by Dr. Kenneth M. Smith (*J. Roy. Hort. Soc.*, **74**, Pts. 11 and 12; 1949), the whole subject of plant virus pathology is reviewed, and teachers will find them a very useful and well-illustrated summary of modern knowledge. With regard to the field of virus-insect relations, several new and useful points of view are expressed. Dr. Smith considers that the evidence for multiplication of the virus within an insect vector has not been, on the whole, very conclusive. He cites, however, the case of clover club-leaf virus, which retains infectivity over fifteen generations of its specific leaf-hopper vector. This would involve a dilution calculated at 10^{-17}. No known virus appears to be able to sustain such a high dilution, and this discovery is perhaps the best piece of evidence that a virus can multiply within its vector. It is also stated that, for non-persistent viruses, a short feeding time for an aphid of 3–5 minutes imparts maximum infectivity. Non-persistent viruses, indeed, seem to be carried only by aphids. Persistent viruses, on the other hand, may have leaf-hoppers, aphids and thrips as vectors.

New Displays at the British Museum (Natural History)

In the July issue of the *Museums Journal*, Mr. J. P. Doncaster, who is in charge of the exhibition section at the British Museum (Natural History), describes some new displays of exhibits that have been installed recently. The classification of the vertebrates is the first subject dealt with, and here the aim is to present the basic facts required by the student of biology. To this end the existing wall-cases were stripped of internal fittings and replaced by sloping display boards. Fluorescent tubes provide internal lighting. In general, the exhibited material is on the lower boards, while the upper are used for charts and diagrams. A neutral-grey fabric is used as a background, and labels are of two types. General and explanatory labels are given prominence by being printed on cream paper, while the individual labels for the specimens are printed on a grey paper which tones with the background. Another exhibit, on virus diseases, is also described. In conclusion, Mr. Doncaster deals with the systematic type of exhibit, especially in relation to mammals and birds. This pioneer article will be found to be of especial interest to all those engaged in modern museum display.

Research Committee for the Gas Industry

The Gas Council announces that it has set up a research committee consisting of Sir Edgar Sylvester (chairman of the Gas Council); Sir Robert Robinson and Sir Cyril Hinshelwood (as two men of science not engaged in the gas industry); Mr. E. Crowther, Dr. R. S. Edwards, and Mr. W. K. Hutchison (members of the Gas Council); Mr. F. M. Birks (president of

the Institution of Gas Engineers); and Prof. A. L. Roberts (Livesey professor of coal gas and fuel industries in the University of Leeds). The laboratories of the North Thames Gas Board have been recognized as the nucleus of a London research station, and Dr. H. Hollings, who for some years has been controller of those laboratories, has joined the committee as director-designate of the station.

University of Glasgow: Fifth Centenary

THE University of Glasgow will celebrate its fifth centenary during June 1951. Representatives of universities, learned societies and public bodies and persons distinguished in academic and public life are being invited. The main ceremonial functions will be during June 19–21, culminating in a visit by the King and Queen on the last day. The meetings will include the presentation of addresses by delegates in the Bute Hall of the University, a commemoration service in the Cathedral, and meetings in St. Andrews Hall, including an honorary graduation. The Fifth Centenary Medal in bronze, 2½ in. diameter, is now being struck. Publications will include an illustrated brochure upon historical and contemporary aspects of the University; a volume of Fifth Centenary Lectures which will be delivered during the 1950–51 academic session; a history of the University; and "The Book of The Fifth Centenary", which will be the official record of the occasion. The arrangements are in the hands of the University of Glasgow Fifth Centenary Committee, Glasgow, W.2, the secretary of which is Mr. J. B. Neilson.

Fourth Congress of the International Scientific Film Association

THE fourth Congress of the International Scientific Film Association will be held in Florence during October 14–22. As in the case of the three previous Congresses held in Paris, London and Brussels, there will be a festival of scientific films, as well as specialist group meetings of the Medical, Research Film and Industrial Film Committees, and also the business meetings of the general assembly of the Congress. A special committee of the British Scientific Film Association has been formed to recommend films for submission to the festival, and prospective exhibitors should, as soon as possible, send to the Association full details about their films, including running-time, gauge, date of production, brief synopsis, etc. The address of the British Scientific Film Association is 4 Great Russell Street, London, W.C.1.

U.S. National Academy of Sciences: Autumn Meeting

THE autumn meeting of the U.S. National Academy of Sciences will be held at the Research Laboratory, General Electric Co., Schenectady, New York, during October 9–12. On the afternoon of October 9 the new buildings of the Research Laboratory will be dedicated, and C. E. Wilson, president of the General Electric Co., will be the principal speaker. On the evening of October 10 Dr. C. P. Rhoads, director of the Sloan-Kettering Institute for Cancer Research, will deliver a public lecture in the Memorial Chapel, Union College. The Academy dinner for members, guests and members of the Capitol District Sections of Technical Societies will be held on October 11, and Sir Lawrence Bragg, Cavendish professor of experimental physics in the University of Cambridge, will be the principal speaker.

Announcements

A MEMORIAL window to the late Sir Charles Parsons will be unveiled in Westminster Abbey on October 5 by Sir Robert Robinson, president of the Royal Society. The window will be dedicated by the Dean of Westminster, and a memorial oration will be delivered by Sir Frank Smith.

THE Council of the British Coal Utilisation Research Association has appointed Mr. R. L. Brown to succeed the late Dr. D. H. Bangham as director of research laboratories. Mr. Brown joined the staff of the Association in 1938, having earlier taken first-class honours in the Mathematical Tripos at Cambridge.

MR. J. S. SHEPPARD has been appointed to the University readership in mine surveying tenable at the Imperial College of Science and Technology, London.

THE Edward Teshmaker Busk studentship of £300 a year for research in experimental and mathematical aeronautics carried out in Great Britain or abroad has been awarded for the year 1950–51 to Robert Westley, of the College of Aeronautics, Cranfield.

THE Institute of Biology, which held its first general meeting in King's College, London, on January 5 (see *Nature*, **165**, 131; 1950), has now obtained office premises at 17*a* Onslow Gardens, London, S.W.7, telephone number Kensington 4882–3. Mr. A. Fielding Clarke has been appointed general secretary. All communications should be addressed to the general secretary, who will be glad to supply further information to prospective members.

THE Physical Society will hold a symposium on cosmic rays on September 29, and on November 24 a number of papers will be given on various aspects of electrical discharge. On December 8 the autumn provincial meeting of the Society will be held at Cambridge, when Sir James Chadwick will deliver the Rutherford Lecture. Further details of these meetings can be obtained from the Secretary, Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

THE twenty-first annual conference of the National Smoke Abatement Society will be held at Margate during September 27–29. The Conference will be marked by the presentation of the first Des Voeux Memorial Lecture, established in honour of the Society's first president, Dr. H. A. Des Voeux, who helped to found one of its two parent bodies in London in 1899. It will be delivered by Dr. D. T. A. Townend, director-general of the British Coal Utilisation Research Association. Further particulars of the Conference can be obtained from the general secretary of the Association, Chandos House, Buckingham Gate, London, S.W.1.

THE twelfth National Conference for the Preservation of the Countryside, organised by the Council for the Preservation of Rural England, will be held at Tunbridge Wells during October 19–22. The theme this year will be "Modern Developments in Rural England", and three sessions on, respectively, the impact of industry on rural life, problems of rural electrification, and planning and afforestation, will be held in the Assembly Hall, Tunbridge Wells. The headquarters of the Conference will be at the Spa Hotel, where there will be an inquiry office. Further details can be obtained from the Secretary, C.P.R.E., 4 Hobart Place, London, S.W.1.

CONCEALED COALFIELDS OF THE MIDLANDS

SINGULARLY appropriate to the presidential theme of "Man's Use of Energy", and also to the Birmingham setting of the British Association meeting, was the discussion held by Section C on the subject of "The Concealed Coalfields of the Midlands". This discussion followed naturally the accounts of the work of Charles Lapworth which had been delivered on the previous day.

Prof. L. J. Wills, in opening his address, paid tribute to Lapworth's report on the Midlands, made to the Coal Commission of 1905; but explained that since that time so much new information has been acquired that it is necessary to analyse afresh the geological factors determining the distribution of Coal Measures throughout the area. Nearly all the valuable coals, Prof. Wills pointed out, are contained in the productive coal measures below the Aegir (Mansfield) Marine Band, and zoning has shown that this coal-belt thins towards the south due to non-deposition of sediments. Shortly after these coals were laid down, there followed, in the early stages of the Upper Coal Measures, the first Malvernian folding and erosion, which removed the coals from a large area in Shropshire. Prof. Wills also believes that it was at this time, and not later, that much of the erosion took place in the Pennine anticline and in Charnwood. Afterwards, the second Malvernian folding, at the end of the Keele–Enville period, produced sharp anticlines and reversed faults in certain narrow belts. In Enville times, sedimentation was confined to the down-warps, but little erosion took place from the up-warps except in a region south of Birmingham, where the 'Mercian Uplands' had begun to rise. The period that followed was one of vertical block-movements with the establishment of well-defined horsts and graben. During the Clent Breccia and Bridgnorth Dune Sandstone stages the horsts were being denuded at the same time as sedimentation took place in the graben. Later, the area of deposition extended during the Bunter Pebble Beds and Keuper and a great levelling-up took place. Further vertical displacements of the fault blocks were brought about by post-Triassic movements, and subsequent denudation of the resultant horsts has exposed the five Midland coalfields. In the intervening areas the cover of New Red rocks is extremely variable, both in nature and thickness.

Prof. Wills illustrated his thesis by a comprehensive series of maps in which each stage in the development processes was demonstrated. The results of his analysis were summarized in a final map showing his conclusions regarding the extent of the present hidden coalfields and the probable depths of cover.

Dr. G. M. Lees then presented an account of geological deductions from geophysical work by the Anglo-Iranian Oil Co., Ltd., bearing on the prospect of Coal Measures in the South Midlands area. In his opening remarks, he explained that his interest in the extent of Coal Measures was incidental to the search for oil, and arose because the conditions under which oil had been found in carboniferous rocks of the East Midlands monocline had encouraged a search for further areas in which similar structures might retain a considerable cover of Coal Measures. An analysis of the main structural trends which had affected southern England, particularly when considered in relation to the structure of northern France and the lowlands of Europe, led him to believe possible a wide extent of concealed Coal Measures. Dr. Lees pointed out that over much of southern England the average density of boreholes which have proved Palæozoic rocks is only one in approximately 600 square miles, and the Anglo-Iranian Oil Co. had therefore set out to gain further information from geophysical work. Lantern slides were shown giving contour maps of Bouguer gravity anomaly summarizing the results of the gravimeter surveys. These surveys revealed, in a number of areas, gravity lows, which persisted as areas of low gravity after allowance was made for the effects of known and estimated thicknesses of Mesozoic cover. Extensions of the gravimetric observations revealed gravity lows in close association with the coal basins of the Kent and Bristol coalfields, and on the basis of these associations the gravity lows in a belt south of Worcester and in areas near Oxford, near Redhill, and in the Thames estuary were regarded as indicating the presence of further Coal Measure basins.

In certain areas the gravimetric surveys had been followed up by seismic work, and a high-velocity medium, interpreted as the Carboniferous Limestone, had been followed at depths of the order of 6,000 ft. Though the methods employed could not differentiate between Upper Carboniferous and Triassic rocks, nevertheless, since in these areas a great thickness of Trias was unlikely, the seismic results therefore appeared to support the conclusions reached from interpretation of the gravimetric measurements. Some geophysical work is still in progress and it is desirable that the survey should be supported by suitable boreholes. In conclusion, Dr. Lees expressed the view that investigations of this nature could play a part in the exploration for further coal resources.

Mr. T. Eastwood, who followed, said that for some years his attention had been turned to the possibility of potential coal resources in the area between the South Staffordshire and Warwickshire coalfields. Basically, he had approached the problem by asking three questions: first, has any coal ever been there?; then, if so, how much was there originally?; and finally, how much now remains? Similarities in the coal sequences of Warwickshire and south Staffordshire suggest that they were deposited in a single Coal Measure basin, and that similar deposition must have taken place in the area between the two coalfields. The present arrangement of Keele and Etruria outcrops in the Warwickshire coalfield shows that the dominant structure is a syncline pitching southwards. In the South Staffordshire coalfield, although the most northerly beds show a westerly dip, the main structure is also a syncline pitching south, and consideration of conditions at the margins of the exposed coalfields suggests that this structure is again repeated in the area between the two coalfields. A complicating factor, however, is the presence of the Hints Fault, which might have a considerable downthrow to the south-east. Outcrops of lower beds of the Trias near Lichfield appear to reflect an anticline crossing the inter-coalfield syncline, and in 1949 a Geological Survey boring was drilled on this anticline north-west of the

Hints Fault. In this boring were proved 30 ft. of workable coals at depths of less than 3,000 ft. The succession encountered can be correlated closely with that of the Cannock area, thus suggesting the existence of a considerable concealed coalfield extending from the north-eastern margin of the South Staffordshire coalfield into the Lichfield area.

Prof. W. G. Fearnsides next gave some details of explorations carried out in the West Midlands by the National Coal Board during the past few years. He dealt first with the area to the north-east of Cannock Chase where, about two years ago, a boring programme was started in the hope of reinforcing the dwindling resources of Brereton Colliery, south-east of Rugeley. Almost at the same time as the Survey boring at Whittington, the first boring outside the eastern boundary fault was drilled at Redhill. This entered the Coal Measures at considerably less than 1,000 ft., afterwards proving the full Cannock succession of coals. Further borings to the north and north-east all proved the workable coals, which appear to lie in a shelf at least two miles wide and thrown down about 1,000 ft. from those of the exposed coalfield. In this area the quality of the coals is good, and seam gradients, indicated by the bore-holes, extremely low. Prof. Fearnsides went on to describe the explorations by which new resources have also been proved east of the Coalbrookdale coalfield in areas north-east of Lilleshall and in the Madeley syncline. Further explorations are being made in several areas west and east of the South Staffordshire coalfield and south of the Warwickshire coalfield. Up to the present, from twenty deep borings in the West Midlands, considerable new resources have been proved.

The final speaker, Dr. G. H. Mitchell, dealt with the area east of the Warwickshire coalfield, and summarized information which has recently been made available from operations in that area by the National Coal Board and the Directorate of Opencast Coal Production. Recently, the limits of the South Derbyshire–Leicestershire coalfield have been proved to run from Desford, through Nailstone, Heather and Snarestone, to Netherseal. North-east of Netherseal the coals lie in a roughly basin-like structure, interrupted by many local contortions and faults. The basin is broken on the west by large faults beyond which the Coal Measures have not yet been proved. On the east side of the coalfield the Thringstone Fault is now known to be a large reversed fault. Between the South Derbyshire–Leicester coalfield and the Warwickshire coalfield, borings at Market Bosworth have proved Cambrian strata. The eastern extension of the Warwickshire coalfield is still unproved.

In the open discussion which followed, Mr. W. Bullerwell displayed maps showing some results of a gravimetric survey made by the Geological Survey over an area connecting the Coalbrookdale coalfield and the northern parts of the South Staffordshire and Warwickshire coalfields.

Dr. C. J. Stubblefield stated that the southern coalfields of the Midlands appear to be faunally connected with a province south of the Brabant Massif, and that certain differences between their marine faunal assemblages and those of the South Derbyshire coalfield suggest that in Coal Measure times a barrier may have existed between the coalfields of Warwickshire and South Derbyshire. Supplementing Mr. Eastwood's remarks on the Whittington boring, Dr. Stubblefield added that the lower section has proved fossiliferous Millstone Grit, Carboniferous Limestone of northern facies, and—a rarity in the Midlands—fossiliferous Upper Old Red Sandstone.

Dr. P. E. Kent said that from the investigations east of Charnwood by the Anglo-Iranian Oil Co., it appears possible that a deep syncline containing Coal Measures exists near Grantham. Coal Measures may also be present in the Melton Mowbray area in troughs adjacent to the boring at Sproxton which, drilled on an anticline, has proved Millstone Grit.

Prof. L. R. Moore outlined similarities between beds which were deposited about the time of Malvernoid movements in the South Wales–Bristol district and corresponding sections in the Midlands which had been described by Prof. Wills.

The large and representative audience was a clear indication that the meeting had aroused wide interest. From the particular point of view of a geophysicist, the proceedings demonstrated forcibly the absolute indispensability of the classical methods of pure deductive geology in the search for new coal resources, and also afforded a clear statement of the many questions which geophysical techniques must be able to answer before they can be considered to have graduated in coal measure problems. While present geophysical methods may assist greatly in the reconnaissance for new coalfields, the geologist and mining engineer require extremely detailed information before seam correlation, gradients and quality can be established firmly enough to support constructive planning. Only in exceptional circumstances can current geophysical methods give sufficiently accurate information at this stage, and there is therefore a need for further application and refinement. In view of this, it seems appropriate to conclude by expressing good wishes to the Department of Geophysics newly established under the Department of Geology at the University of Birmingham. In the light of the discussion, this new Department is not likely to be short of problems close at hand.

EXPERIMENTAL WORK WITH ATOMIC PILES

AT the Birmingham meeting of the British Association, four papers were presented in a discussion arranged by Section A (Mathematics and Physics) on "The Application of Atomic Piles to Experiments in Nuclear Physics". The experiments related to the properties of the neutron itself, the properties of atomic nuclei and the application of the atomic pile to the study of solids.

Dr. R. E. Bell, of the Chalk River Laboratory, Canada, described an outstanding piece of experimentation in which Robson has measured the energy spectrum of the beta-rays emitted by the natural radioactive decay of a strong beam of neutrons, and has identified the protons produced. He has verified in detail the predictions about the radioactive properties of the neutron. Bell and Elliott have redetermined the binding energy of the deuteron by studying the capture gamma-rays from hydrogen. The new value obtained for the binding energy is considerably larger than the previously accepted value, so that the accepted mass of the neutron has to be raised by about forty parts in a million.

The energy-levels of nuclei have been studied by Kinsey, Bartholomew and Walker, who measured the spectra of capture gamma-rays emitted by a large

selection of elements throughout the periodic table. They measured the energy of electron-positron pairs produced by the gamma-rays. The spectra become more and more complex as the capturing material is made heavier. Lead and bismuth, however, have simple spectra. The reasons for this behaviour are at present unknown.

The neutron cross-sections of nuclei have been studied at the Argonne Laboratory, Illinois, using three different methods. Dr. D. R. Inglis described the different methods used to select neutrons of a single energy. Narrow slits in a high-speed rotor chop neutron beams emerging from slits in a similar stator into short bursts. The reflexion of a light beam by the rotor on to a photo-cell triggers a multi-channel counting system which selects neutrons by their time of flight. The small area of cross-section of the neutron beam between rotor and stator makes possible the study of small samples of separated isotopes which are inadequate for the pulsed cyclotron technique. Nuclear cross-sections at a definite neutron energy can also be studied using resonance scattering of a beam of neutrons from the pile. The sharp scattering resonance of xenon has been used to determine the absorption cross-section of boron at this energy. For higher energies the pile cannot be used to provide a source of monochromatized neutrons. Neutrons with energies between 5 keV. and 1 MeV. can be produced by bombarding lithium with protons, using very careful voltage regulation of the electrostatic accelerator. This is necessary because the reaction threshold is 1·88 MeV.

Beams of monochromatized pile neutrons can also be used for reinforcing the older technique of X-ray diffraction in the study of solids. Mr. G. E. Bacon, of the Atomic Energy Research Establishment, Harwell, described a double-crystal neutron spectrometer in use at Harwell. The first crystal, a few inches square, is used as a monochromator to select neutrons with wave-lengths lying within a narrow band from a collimated beam emerging from the thermal column of the pile. The neutrons diffracted from a second crystal are detected by a counter mounted on a rotating arm.

A comparison of the intensities of lines in the X-ray and neutron diffraction spectra of graphite confirms that anomalies in the X-ray intensities are due to the anisotropic distribution of electrons in each atom and not to any peculiarities of crystal structure. The neutrons scattered by the atomic nuclei show no anomaly.

Whereas the scattering of X-rays increases rapidly with atomic number, the scattering of neutrons is about the same for all elements. Neutron diffraction has therefore the advantage that light elements can be detected in the presence of heavy ones.

The fast neutrons in a pile can cause interesting changes in the physical properties of solids. Mr. T. M. Fry, of the Atomic Energy Research Establishment, Harwell, referred to the experiments of Lark-Horovitz, which demonstrated the production of electron-traps in germanium irradiated in the Oak Ridge pile. Siegel found that samples of Cu_3Au were disordered after prolonged irradiation at Oak Ridge. Dugdale at Harwell, on the other hand, has found that the resistivity of annealed samples of Cu_3Au falls as a result of short irradiations in the pile. This suggests that the degree of order of these samples is increased by the bombardment.

Berman, at the Clarendon Laboratory, Oxford, has observed that the thermal conductivity of a quartz crystal is reduced by successive irradiations at Harwell until its behaviour is more nearly that of a glass. These changes can be attributed to the scattering of thermal waves by clusters of interstitial atoms and vacant lattice points.

Experiments of this type should throw light on the structure-sensitive properties of solids.

T. M. Fry

MANAGEMENT BEHAVIOUR AND FOREMAN ATTITUDE

In a large-scale business enterprise there are many levels of administrative work. The administrator has responsibility for the process of blending productively the economic, technical and business requirements of complex situations. Some of the most perplexing human relations problems in industry, however, are faced by foremen, supervisors, and others in middle management groups, and to observe at first hand some of these problems of human relationships, Messrs. D. R. Ulrich, D. R. Booz and P. R. Lawrence, of the Graduate School of Business Administration, Harvard University, recently spent eight months in a factory in the United States.*

The particular plant chosen for study reflected many of the tensions and instabilities of an intensely competitive industry. It was one of many plants operated by a company with headquarters in New York. The products of the department were four models of a small, delicate instrument which had been invented and produced for only about two years. A great many technical engineering aspects in the production of this instrument were causing trouble continually.

A new general manager had called upon his immediate associates to operate as a management team. These men, all specialists in their fields, met at the manager's call to make or review all decisions concerning the plant.

Between the management team and the direct labour operators was a thin bridge of supervisors, foremen and staff specialists. At the work bench the company employed a large number of semi-skilled workers. These operators worked on production lines that were continually being revised according to the dictates of the engineering department as interpreted by the foremen.

Preoccupied with the demands made upon them by the hourly employees and the staff specialists, the supervisory personnel felt they did not themselves have adequate capacity to deal with these demands. Yet their efforts to get the help they needed from general management were not successful; instead, 'management' made the strongest demands of all.

The research group felt that a close knowledge of the personnel at each level would be necessary to understand the reasons for the gap between general management and other personnel. The team therefore spent about half its time in the plant talking with, and observing the activities of, thirty-six women who were hourly-paid employees in one department.

Although none of the women ever stated their problems in these words, it seemed to the observers that the only way the women felt they could make their factory life interesting and meaningful was

*Management Behavior and Foreman Attitude: a Case Study. By David N. Ulrich, Donald R. Booz and Paul R. Lawrence. Pp. vii+56. (Boston, Mass.: Graduate School of Business Administration, Harvard University, 1950.) 75 cents.

through conversation with one another and through the development of informal groups. The frequent changes in the department kept disrupting these activities, and the women developed feelings of insecurity which manifested themselves primarily in an attitude of hostility toward management, an attitude which even the women themselves did not quite understand.

The foreman of the department formed the main link between the higher members of management and the hourly employees. Since a distinct gap existed between management and the employees, since these groups frequently misunderstood each other, and since each tried to exert various kinds of pressure on the other, the position of the foreman was at once critically important and critically difficult. Caught squarely between these opposing pressures, he faced daily confusion, doubt and conflict in trying to reconcile them.

The employees viewed the foreman as an instrument of management. But what, in fact, were the foreman's relation with management ?

In the foreman's opinion, the superintendent entered the department only to criticize such matters as the way the floor had been swept. The foreman wished to see as little as possible of the superintendent and to receive as few instructions from him as possible. Critically significant to the foreman was the fact that he and his immediate supervisor were held solely responsible for the correlation of all requirements set up by staff personnel as well as 'line' superiors.

Missing from the situation was an effective method for translating special technical knowledge into terms that would be useful to the line personnel, and for translating line problems into terms that would have meaning to the specialists. The barrier that prevented this give-and-take from occurring was not in any sense a technical barrier but rather one of hostile attitudes between groups competing for greater control of the work.

The report indicates that the management of the company held in its own hands the key to many of the most critical human relationships in the plant; and that the turning of this key depended upon management's own behaviour. Yet rather than try to understand how the employees viewed management, management was preoccupied with trying to get employees to "understand things our way".

In these circumstances, it seemed imperative to the research group that management should stop worrying about getting its own message across to the employees and concentrate on finding out what the employees were trying in various ways to tell management. Only by so doing could management effectively narrow the gap existing between itself and the employees, including those at the supervisory level.

A characteristic of the pattern observed by the investigators was the self-perpetuating nature of the gap in communication between senior management and subordinate levels of the organisation. They concluded that a first step in bridging this gap would be for senior management to see more clearly what its own role in maintaining the gap had been.

In closing, the authors of this report stated that the most promising development in the company was the effort the general manager was making to increase his own understanding of the human factors in his administrative work. His efforts held the most significant kind of promise for the future.

T. H. HAWKINS

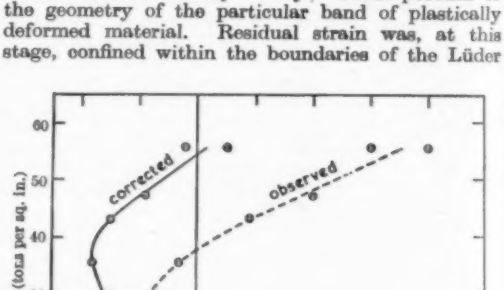
RESIDUAL STRAINS IN PLASTICALLY DEFORMED MILD STEELS

USING an accurate back-reflexion X-ray technique, residual strains in plastically deformed low-carbon steels (0·06–0·15 per cent C, 0·27–0·67 per cent Mn) were evaluated from the values of lattice spacings of planes lying parallel to the surface of previously extended plate-tensile specimens. The diffusion of the $K\alpha$ doublet, accompanying plastic deformation of the specimens, affected the photometrically measured diameter of the diffraction rings, introducing a fictitious lattice contraction. A correction for this deviation was applied by a method described previously[1]. The accompanying graph shows measured and corrected lattice strains for the {211} planes of a typical sample.

All specimens were ground from larger stock materials. Preliminary heat treatment *in vacuo* or in an inert atmosphere appeared to give consistent results, and the use of different mild surface etchants seemed without effect. No significant initial preferred orientation was detected in any specimen.

Axiality of loading was found to be of extreme importance, and the recording of a very clearly defined upper yield point was adopted as a criterion for axiality[2]. After unloading from within the mechanically determined elastic range, no residual strain of the type observed by Garrod[3] was detected. Pre-yield residual strain was confined entirely to specimens in which the initial loading was sufficiently eccentric to cause the suppression of the upper yield point.

In the large tensile specimens (0·1 in. × 0·5 in. cross-section) used in this investigation, the onset of plastic deformation was marked by the formation of a Lüder line, and yielding resulted in the creation of an inconsistent body strain with superimposed Heyn strains. This inconsistency, it is suggested, may be attributed to the heterogeneous plastic deformation within the confines of the Lüder line[4] and to the state of non-axial loading introduced by its presence, which results in a body or 'layer' strain peculiar to the geometry of the particular band of plastically deformed material. Residual strain was, at this stage, confined within the boundaries of the Lüder



line, and no support could be given to the observation by Cowley and Paterson[5] of diffuse spots on stationary diffraction photographs of the material adjacent to the line.

Throughout the range in which the specimen exhibited 'uniform' external plastic strain, the lattice strain appeared to be a simple function of the initial stress and characteristic for each set of crystallographic planes. These results agreed, in order of relative magnitude, with those obtained by Greenough on wire specimens[6]. Discontinuous yielding, however, associated with the comparatively large rectangular specimens, resulted in a shift of all the individual Heyn strains in accordance with the inconsistent body strain, and an approach to consistency could only be obtained by adopting the post-yield residual strain as an arbitrary zero for subsequent strain increments (see graph). Reduction to an arbitrary strain of $+ 1 \times 10^{-5}$, for the {211} spacing, gave the following strain relationship after a plastic deformation of approximately 19 per cent:

Lattice planes	{310}	{211}	{220}
Strain $\times 10^5$	+20	+1	−24

After exceeding the nominal maximum stress, plastic flow became localized with the formation of a neck. All lattice planes tended towards residual contraction as necking proceeded (see graph). This suggested the development of a further body strain, which increased in magnitude with increasing severity of necking. The formation of this strain is consistent with the constrained recovery of the specimen as a whole from a duplex deformation mechanism, the core of the specimen having been subjected to an increasing triaxial tensile stress system while the surface has remained free to become deformed by shearing. To account for a body strain of the observed sign, it is necessary to postulate a relatively increased elastic range for the metal within the internal zone of triaxial stress. Such an assumption appears reasonable on theoretical grounds (cf. similar mechanism proposed by Greenough for residual lattice strains in plastically deformed copper and aluminium specimens[7]).

Body strains would be expected to depend on the size of the specimen (assuming an approximately constant crystallite size). A significant reduction in magnitude of the assumed body-strain component was, in fact, observed with a small tensile specimen (ground and lapped to 0·02 in. × 0·15 in. cross-section).

When comparing the behaviour of the ferrite matrices in analytically similar steels showing spheroidal carbide and ferrite–pearlite structures, respectively, the corrected systematic lattice strain curves were found to be similar provided that the steel was initially in a reasonably strain-free condition. There was, however, one significant difference observed between the two samples: at constant plastic strain, the breadth of the diffraction lines (measured conveniently as the α_1–α_2 doublet half-height width) was greater for the sample showing spheroidal carbide. A ready explanation for this observation can probably be given in terms of textural strain, which is greater for the sample with spheroidal carbide simply because there is an even distribution of small carbide particles in all ferrite grains, whereas in the other sample a majority of grains are pure ferrite, free from all disturbing carbide inclusions.

Summing up, in low-carbon steel the systematic residual strain in the ferrite matrix is confined to the plastic region and appears to be determined primarily by its inherent anisotropic characteristics and by the geometry of the test specimen.

I wish to express my appreciation of the interest taken in this investigation by Prof. J. H. Andrew, and to thank the Chief Scientist, Ministry of Supply, for permission to publish this communication.

L. G. Finch

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April 27.

[1] Finch, L. G., *Nature*, **163**, 402 (1949).
[2] Warren, A. G., Inst. Met. Symposium, 209 (1947).
[3] Garrod, R. I., *Nature*, **165**, 241 (1950).
[4] Winlock, J., and Leiter, R. W. E., "The Working of Metals", 163 (Amer. Soc. for Metals, 1936).
[5] Cowley, J. M., and Paterson, M. S., *Nature*, **159**, 846 (1947).
[6] Greenough, G. B., *Metal Treatment*, **16**, 58 (1949).
[7] Greenough, G. B., *Proc. Roy. Soc.*, A, **197**, 556 (1949).

In an earlier communication[1] values were quoted for the residual lattice strains in iron after a plastic extension. More recent work has shown that, although the relative values were correct, their absolute magnitudes were in error. The error in the early work arose because the material used for the experiments was not, in fact, iron, but a mild steel which also contained small percentages of alloying elements. The annealing treatment given to the wires after plastic deformation not only removed the residual lattice strains, but also caused some metallurgical change which led to an increase in the unstrained lattice parameter. This latter change in lattice spacing was included in the residual lattice strain quoted, and consequently the values were all about 6×10^{-5} too small (algebraically).

In order to confirm that the correction applied to earlier results led to accurate values, the residual lattice strains have been measured in plastically extended wires of a mild steel (C = 0·10 per cent, Mn = 0·36 per cent, Si = 0·017 per cent, P = 0·007 per cent) which was free from variations in annealed parameter. Two series of results were obtained corresponding to two amounts of plastic extension, and these are shown in the accompanying table (cols. Nos. 2 and 3), together with the corrected values of the earlier results (1).

Plane reflecting	Residual lattice strains		
	Earlier results (corrected) 1	Confirmatory results 2	3
	$\times 10^{-5}$	$\times 10^{-5}$	$\times 10^{-5}$
310	+24	+30	+22
211	+7	+11	+9
110	−25	−6	−2
True stress previously applied (lb./sq. in. $\times 10^{-4}$)	7·3	5·3	4·2
Plastic extension (per cent)	19	15	10

If these values are plotted as before against the orientation function φ, the derivation of which has been described elsewhere[2], the gradients of the three straight lines obtained are approximately proportional to the stress applied to the aggregate. This is in accord with the quantitative interpretation of the Heyn intergranular stress explanation previously adopted. On the other hand, the average residual lattice strain (which is equivalent to the intersection of the graph with the residual lattice strain axis) is

markedly positive, and not zero as the Heyn stress theory anticipates. Thus mild steel shows the same type of compressive macroscopic stress superimposed on the Heyn stresses as has been discussed elsewhere[2]. In this discussion it was shown to be probable that a compressive stress is likely to arise in the surface layers of an aggregate because grains with a free surface would be softer than those of the same orientation in the interior of the aggregate. Experimental work which is just being concluded has shown that the surface layers of a plastically extended specimen do contain macroscopic compressive stresses, and if these are removed the mean of the observed residual lattice strains becomes much more nearly zero.

This surface compressive layer could be regarded as a particular case of the body strains arising from discontinuous yielding, to which Finch[3] attributes his anomalous results; but it seems unlikely that the geometry of the specimen would much influence the surface stress layer unless the specimen size were made of the same order as the grain size of the aggregate.

Recently, Garrod[4] has said that the explanation of residual lattice strains based on Heyn stresses "involves the assumption that, in a randomly orientated polycrystalline aggregate deforming under, for example, a tensile stress, some grains, in which the glide planes and glide directions are suitably orientated with respect to the stress direction, will yield *before* their neighbours". That some grains must undergo appreciable plastic strain before others yield is a misconception, and may have resulted from insufficient clarity of expression in my earlier papers. In these, the term 'yield tension' of any grain has been used for describing the tensile stress required to cause further plastic flow in that grain, and not the stress required to initiate plastic deformation in the annealed crystal. It was always supposed that if the plastic extension of an aggregate was appreciable, say greater than 0·5 per cent, then slip must have occurred in *all* the grains. This was because the elastic limit of even the hardest grain does not exceed 0·2 per cent, and it appeared unlikely that contact would be maintained between the various grains in an aggregate during a plastic extension of 0·5 per cent if the strains in some grains were less than 0·2 per cent. The whole of the quantitative treatment was based on this assumption. The particular experimental observation by Garrod that grains of all orientations start to become deformed plastically at about the same macroscopic strain value is thus in accord with the general basis of the explanation of residual lattice strains in terms of Heyn stresses.

However, the residual lattice strains observed by Garrod, by Finch and by myself in mild steel specimens after the application and removal of tensile stresses exceeding the macroscopic yield stress of the aggregate, all confirm the view that, whereas Heyn intergranular stresses make a considerable contribution to the observed residual lattice strains, other stress systems must also be present.

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[1] Greenough, G. B., *Nature*, **160**, 258 (1947).
[2] Greenough, G. B., *Proc. Roy. Soc.*, A, **197**, 556 (1949).
[3] Finch, L. G., *Nature* (see previous communication).
[4] Garrod, R. I., *Nature*, **165**, 241 (1950).

HABITS AND LIFE-CYCLE OF *CULICOIDES NUBECULOSUS* MG.

By J. A. DOWNES

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OBSERVATIONS on the blood-sucking midge *Culicoides nubeculosus* Mg. (Diptera: Ceratopogonidæ) have been made in Nature at Chideock, Dorset, and in the laboratory. The results provide some interesting comparisons with recent work on mosquitoes and other Nematocera.

Around Chideock, *C. nubeculosus* inhabits farmyards. The larvæ live in hoof-print puddles heavily contaminated with the excreta of cattle, and the adults rarely stray as much as a hundred yards from the larval habitat. The natural food of the adults of this strain is unknown; they do not bite man in Nature, although they will do so readily in the laboratory. Elsewhere, the species is known to feed on man and on horses. All observations indicate, however, that a blood meal is essential for the development of the eggs.

Male swarms. Around and after sunset, and again after sunrise, small discrete swarms (less than a hundred individuals) of the midge were observed along a light-coloured sandy road running through a farmyard. The swarm consisted of males only, performing a very characteristic side-to-side dancing flight with occasional vertical excursions. The swarms were columnar and extended from 2 ft. to about 8 ft. above the ground. In the swarm, the midges all faced towards the slight wind, from whatever direction it was blowing (a stronger wind inhibits flight); and the swarm as a whole remained stationary directly above a well-defined object. Natural 'swarm-markers' included pads of cow-dung and patches of dark mud, wet or dry, lying on the paler road; similarly, swarms could be produced at will by laying down a 20–100-cm. sq. black cloth. The first midge to arrive over such a cloth immediately starts to perform the characteristic swarming dance and will continue for perhaps several minutes, until others arrive and a typical swarm is built up.

These observations show that swarming depends on the visual responses of the midge to a 'swarm-marker', in this case a dark object of appropriate size, which viewed from moving air appears to be travelling forward. Similar responses have been demonstrated in unfed females of *Aëdes ægypti*[1]. Since each insect is responding independently to the common 'marker', and there may in the limit be only one present, it is not, on the first analysis at least, a true gregarious phenomenon. 'Swarms' consisting of single insects have been observed also in *Aëdes cantans*[2].

Mating. Gibson[3] has shown that, in *Spaniotoma minima* (Chironomidæ), males and females both take part in the swarming dance. Eventually mating occurs, the pair fall to the ground, and the fertilized females do not rejoin the swarm. Thus in any well-established swarm, females are in a considerable minority. In *C. nubeculosus* (and six other species of *Culicoides*) all swarms examined consisted entirely of males. Nevertheless, midges *in copula* have twice been found on the 'swarm-markers'. Presumably females sometimes enter the swarm, and when this happens mating takes place almost instantaneously. Probably, however, the swarm is not the only, or even an important, occasion of mating, since in

captivity pairing occurs readily in 3 in. × 1 in. glass tubes, in which flight is severely restricted (compare the case of *Anopheles maculipennis* var. *atroparvus*[4]). Moreover, males will mate with the completely immobile females actually engaged in biting, as already noticed by Pomerantzev[5]. All three types of mating last some two to three minutes and result in successful transfer of sperm to the spermatheca of the female.

Roth[6] found that the mating reflex of *Aëdes aegypti* is elicited by the characteristic sound of the female in flight, which is perceived by the long auditory hairs of the male antenna. Males of *C. nubeculosus* also possess these antennal hairs, which are erected during swarming but usually decumbent at other times. Mating in the swarm, and possibly in more confined spaces also, seems to depend on this mechanism; but mating with immobile feeding females must be a radically different case.

Activity of the females. The daily cycle of activity of the females has been investigated by sweep-net collections made at hourly intervals. There are distinct evening and morning peaks of activity, corresponding roughly to the two periods of male swarming. A few females are active also at other times of the day and night. The evening peak is three to four times as great as the morning peak. The excess of females in the evening were found, on dissection, to have large ovaries containing ripe eggs apparently ready for laying. The remainder of the evening fliers, the morning fliers and those taken at other times, almost all had small ovaries with undeveloped oocytes. Females with ovaries in any intermediate condition were rare. It was also very unusual to capture individuals with blood in the stomach.

The females with small ovaries that fly both in the evening and in the morning (perhaps a mixture of newly emerged insects and older ones that have recently oviposited) are probably in search of a blood meal. Having fed, they hide and do not become active again until the meal has been digested and the eggs have matured; they then show only one very sharply defined (evening) period of activity. No such distinct on between two age-groups showing different cycles of activity appears to have been made in studies on mosquitoes, possibly because the techniques commonly used are adapted to record only insects that are ready to bite.

Egg-laying. When an attempt was made to induce evening-caught females with ripe eggs to oviposit, it was found that those set up singly in suitable 3 in. × 1 in. tubes usually failed to lay though they might live for several weeks, whereas others left together in the tube in which they had been collected oviposited overnight. In a small experiment, only one out of ten females in individual tubes oviposited during the night following capture, as against ten out of twelve set up in three groups of four per tube. This remarkable density-dependent factor for oviposition has since been confirmed using laboratory-reared insects. The nature of the factor is unknown, and attempts to observe oviposition in the field were not successful.

Biting and longevity. The Chideock strain of *C. nubeculosus* is being maintained in the laboratory, where the complete life-cycle may be as short as three weeks. Females will not bite until two to three days old; but an activity factor is also involved, since those kept in 3 in. × 1 in. tubes often refuse to feed at all although given daily opportunities, while those in larger (1½ cu. ft. approximately) cages almost all bite on the third day after emergence. Egg-laying takes place, if the females are suitably concentrated, four to five days after the blood meal, and the insect is then ready to bite again immed ately and in due course to lay. As many as five successive batches of eggs have been obtained from a single female; mating in this case had taken place once only (at the time of the first blood meal), but more than 80 per cent of each batch hatched. Adult females may live for rather more than a month.

A fuller account of these studies is in preparation.

[May 8.

[1] Kennedy, J. S., *Proc. Zool. Soc. Lond.*, **109** (A), 221 (1940).
[2] Nielsen, E. T., *Bull. Ent. Res.* (in the press).
[3] Gibson, N. H. E., *Nature*, **150**, 268 (1942).
[4] Cambournac, F. J. C., and Hill, R. B., *Amer. J. Trop. Med.*, **20**, 133 (1940).
[5] Pomerantzev, B. I., *Mag. Parasit., Leningrad*, **3**, 183 (1932).
[6] Roth, L. M., *Amer. Midl. Nat.*, **40**, 265 (1948).

CARNEGIE UNITED KINGDOM TRUST

ANNUAL REPORT FOR 1949

THE booklet issued by the Library Association in connexion with the centenary of the passing of the first Public Libraries Act pays tribute to the part played by the benefactions of Andrew Carnegie in stimulating progress. The thirty-sixth annual report of the Carnegie United Kingdom Trust covering the year 1949* fittingly gives a detailed account of what the trustees have done for the development of library services, more especially as their decision to rehouse the Scottish Central Library seems likely to be their last major contribution in this field. One of their first decisions, on December 22, 1913, was to commission a report on the results of the library grants already given by Mr. Carnegie and on possible future lines of work.

During 1915–19 the Trust made grants to nineteen county councils to enable them to provide and maintain collections of books which would circulate among their villages, and in 1916 the Central Library for Students, known since 1930 as the National Central Library, was founded with the aid of a grant from the Trust, the immediate aim of the Library being to improve the supply of books to students in organised classes of adult education. The Scottish Central Library was established by the Trustees in 1921, primarily as a repository to supplement the resources of the fifteen Scottish county library systems and to supply books to individual readers in other counties. The Irish Central Library was established in 1923, on an earlier scheme for supplying rural libraries with loan collections of books. The period of the Trust's help to the three Central Libraries is now drawing to a close. The grant to the National Central Library, due to finish in 1941, was renewed, as an exceptional measure, during the Second World War and the subsequent five years and will terminate early in 1951. The Irish Library also receives a diminishing grant due to terminate in 1953; but the date at which the Scottish Library will become wholly independent of Trust grants is still uncertain.

* Carnegie United Kingdom Trust. Thirty-sixth Annual Report, 1949. Pp. viii+44. (Dunfermline: Carnegie United Kingdom Trust, 1950.)

Since 1922 the Carnegie Trust has also made grants to the libraries of learned societies participating in the 'outlier library' system associated with the National Central Library, and help has also been given to the regional system of library co-operation, particularly for the compilation of a nucleus union catalogue of all the books available. With grants from 1926 onwards, for book purchase by small municipal libraries, and for supplying basic collections of books to boys' and girls' clubs, to the National Library for the Blind, the Seafarers' Education Service and the British Sailors' Society, as well as to institutions which exist to improve the general standard and status of librarianship, the total expenditure of the Trust upon library services, when existing commitments have been discharged, will amount, in round figures, to £1,640,000.

In the field covered by the Arts Committee of the Trust, the chief event of 1949 was the creation of the independent Drama Board. Financial considerations have precluded the trustees contemplating the establishment, as recommended in the Younghusband report, of a Carnegie School of Social Work, in association with an appropriate university, but a grant of £200 has been made to enable the National Federation of Women's Institutes to repeat in the Isle of Man the pioneer work carried out successfully in the Channel Islands. Satisfactory progress is reported in the two schemes concerned with juvenile delinquency and also from the Young Farmers' Clubs. The Mobile Club experiment in the Island of Mull has led to the formation of the permanent youth clubs and to appointment by the local education authority of a permanent youth officer for the island.

SIDNEY GILCHRIST THOMAS

THE centenary of the birth of Sidney Gilchrist Thomas on April 16, 1850, was commemorated by the Iron and Steel Institute by a special lecture, delivered by Mr. James Mitchell on April 26 during the annual meeting of the Institute.

Educated at Dulwich College and the Birkbeck Institute, London, Thomas intended to adopt medicine as a career; but the untoward death of his father compelled a change of plan. He became a clerk at the Thames Police Court in 1867; but he spent his time outside office hours in the study of science, taking such examinations in metallurgy of the School of Mines as were open to him as an external student. His interest in the removal of phosphorus from iron appears to have been aroused about 1870 while still a student at the Birkbeck Institute. From a study of the available literature he concluded that the non-removal of phosphorus in the Bessemer process was due to the siliceous lining of the converter and the siliceous character of the slag. A period of experimental work at home, later continued by his cousin, Percy Gilchrist, chief chemist at the Blaenavon Works, followed, and in a comparatively short period of time he was able to announce to the Iron and Steel Institute the discovery of the basic Bessemer process, by which ductile steel could be made from pig iron high in phosphorus, a discovery which, by opening up a new section of the iron-bearing riches of the world, revolutionized the steel industry.

The story of his announcement is dramatic. In September 1878 Lowthian Bell read a paper before the Iron and Steel Institute "On the Separation of Phosphorus from Pig Iron", in which, working on the reactions, as they conceived them, which occur in the puddling process for the production of wrought iron, Bell and other metallurgists were endeavouring to eliminate phosphorus by washing processes, the chemical detergents being oxide of iron and similar materials. The most interesting feature of the discussion of this paper was that it provided the opportunity for Thomas to make the first public intimation of his own success in solving the great metallurgical problem of the time. An eye-witness records: "I remember distinctly the pitying smile of derision and the stony stare which pervaded the countenances of the distinguished assemblage. No one thought it worth while to refer to Mr. Thomas's claim or ask him 'How he did it'."

Within a year a paper was presented which was to establish the truth of the young man's claim. A paper by Thomas and Gilchrist on "The Elimination of Phosphorus" was prepared for the autumn meeting of the Institute held in Paris in 1878. The time, however, was not available to permit of it being read and discussed; but at the spring meeting of the following year a complete process, commercially proved, was given to the world. The delay at the Paris meeting had one further important, and probably decisive, result on the development of the process. The pre-print of the paper and a meeting with Thomas interested Mr. E. Windsor Richards so much that he obtained the consent of his directors to proceed immediately with trials on a works scale at Bolckow Vaughan's plant at Middlesbrough, the results of which added immeasurably to the rapid commercial development of the process. When in due course the subject was discussed by the Iron and Steel Institute during the spring of 1879, the meeting took a form which can be described without exaggeration as an international symposium, the speakers taking part coming from almost every country which at that time had an interest in the solution of the phosphorus problem. The basic Bessemer process was born.

Thomas was industrious to a remarkably high degree, with a highly developed sense of duty and responsibility, and a capacity for liking, and being liked, by a wide diversity of people. It is on record that he appealed to such very different individuals as Andrew Carnegie and William Ewart Gladstone. There is a repeated suggestion in his letters of a strong sense of fun, maybe even of mischief. He certainly possessed the truly great man's first essential characteristic of being ironically amused at his own apparent importance in the sight of others. He had a streak of almost super-caution, and did not relinquish the small but sure competence of his salary as a clerk of the Thames Police Court until the first royalties from his process became available. He also had 'an eye to the main chance', but it was an altruistic eye. Much more successful than many luckless inventors of the period in securing a substantial financial return from his invention, it is worth recalling that these gains—and they must have been considerable—were left, on his early death in 1885, to his sister for the benefit of the workers, or, as he wrote to her, "in doing good discriminately". For our purposes his outstanding characteristics were his pertinacity, patience, and a real ability to lead and inspire those with whom he was associated. Attractive as it may be to dwell on what must have been a very pleasing personality, it is his immense contribution to technical knowledge, the methods by which he made it, and their implications, which still remain important to-day.

F. C. T.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Reaction of Methæmoglobin with Hydrogen Peroxide

It was previously shown[1,2] that methæmoglobin forms with hydrogen peroxide and ethyl hydroperoxide reversible compounds analogous to those which it forms with cyanide, sulphide, azide and fluoride. By spectroscopic and manometric methods it was demonstrated that the formation of methæmoglobin–peroxide requires one molecule of peroxide per iron atom of methæmoglobin[1]. The striking resemblance of methæmoglobin to peroxidase and catalase suggested that further study of the reaction between methæmoglobin and hydrogen peroxide might help to clarify certain points concerning these enzymes, and in particular the mechanism of catalatic decomposition of hydrogen peroxide to molecular oxygen and water.

Methæmoglobin was obtained from catalase-free crystalline horse oxyhæmoglobin by treatment with sodium nitrite or potassium ferricyanide and subsequent dialysis. The quantity of hydrogen peroxide added to it will be expressed in terms of the molar ratio (R) of hydrogen peroxide to hæmatin.

At pH 6·8, methæmoglobin is distinctly brown and shows the spectrum characteristic of the acid form with a band in the red at 635 mμ. On addition of a small amount of hydrogen peroxide the solution turns from brown to red and the absorption spectrum of acid methæmoglobin is replaced by two bands α, 585 and β, 545 mμ, the β-band being stronger than the α-band, which is diffuse and somewhat asymmetric. This change in colour and absorption spectrum is due mainly to the formation of a methæmoglobin – peroxide compound (abbreviated to MetHb-OOH), and its formation is 80 per cent complete when $R = 1$. When $R = 2·5$–5, MetHb-OOH is completely formed; but on standing it decomposes, liberating acid methæmoglobin. During this process part of the methæmoglobin undergoes destruction.

These events have already been described in our previous paper[1], where we have also recorded that the α-band of MetHb-OOH is not only asymmetric but may even appear to have two maxima. The complex nature of this absorption band, together with the fact that both catalase and peroxidase form with hydrogen peroxide several spectroscopically recognizable compounds, has prompted us to examine more closely the spectroscopic changes which accompany the reaction between methæmoglobin and hydrogen peroxide. The double appearance of the α-band with maxima at 592 and 578 mμ becomes more marked as the concentration of hydrogen peroxide is increased. When $R = 25$ the α-band is distinctly double and its components are of almost equal intensity. When $R = 100$ the shorter wave-band at 578 mμ is distinctly stronger than the other band at 592 mμ. When R reaches 250–500, the band at 578 mμ predominates, and after a short time it completely replaces the longer wave-band.

Thus in presence of an excess of hydrogen peroxide, the MetHb-OOH is gradually replaced by another compound, which is easily recognized as oxyhæmoglobin by the positions and relative intensities of its absorption bands as well as by its reaction with carbon monoxide. (That oxyhæmoglobin may be formed as a result of the reaction between methæmoglobin and hydrogen peroxide was already suggested to us in 1936 by Dr. R. D. Barnard[3].) In other words, the trivalent iron of the methæmoglobin – hydrogen peroxide complex, in presence of an excess of hydrogen peroxide, undergoes reduction to the divalent state to yield hæmoglobin, which is oxygenated to oxyhæmoglobin.

Of special interest, however, is the fact that bubbles of oxygen deriving from decomposition of hydrogen peroxide do not appear until the α-band of oxyhæmoglobin becomes visible, and active decomposition of peroxide takes place only when the bands of oxyhæmoglobin are already very marked. This clearly shows that the reaction between methæmoglobin and hydrogen peroxide consists in the formation of MetHb-OOH, which, on further reaction with hydrogen peroxide, brings about its decomposition to molecular oxygen and water, a reaction which is accompanied by valency changes of methæmoglobin iron. In connexion with this reaction, the following points are noteworthy:

(1) The greater the excess of hydrogen peroxide added from the beginning, the more rapid and complete is the formation of oxyhæmoglobin and the more vigorous is the decomposition of hydrogen peroxide. But, however great is the excess of hydrogen peroxide, the appearance of oxyhæmoglobin is always preceded by a transient stage of complete formation of MetHb-OOH.

(2) When the relative concentrations of these two compounds are equal, the α-band of oxyhæmoglobin would appear much stronger than that of MetHb-OOH, since the absolute extinction of its α-band is much greater than that of MetHb-OOH.

(3) The catalatic decomposition of hydrogen peroxide, together with the appearance of oxyhæmoglobin, is soon followed by destruction of the hæm nucleus, since the absorption bands gradually disappear and the solution becomes colourless.

(4) On addition of a suitable acceptor, such as ascorbic acid, which can be oxidized peroxidatically, to a solution showing the absorption bands of oxyhæmoglobin and MetHb-OOH, the latter is rapidly decomposed, liberating methæmoglobin, while oxyhæmoglobin remains unchanged.

(5) All these reactions have been observed with both recrystallized methæmoglobin and metmyoglobin in solutions at pH's varying between 5·5 and 9·2.

Since the peroxidatic and catalytic activities of methæmoglobin, although much lower than those of peroxidase and catalase, are nevertheless very distinct, methæmoglobin can be considered as a suitable model for the study of the reactions catalysed by these two enzymes. As the catalytic decomposition of hydrogen peroxide by methæmoglobin to oxygen and water involves the formation of MetHb-OOH and subsequent valency changes of the methæmoglobin iron, it is reasonable to assume that the similar decomposition of hydrogen peroxide by catalase is also accompanied by valency changes of catalase iron. This view, moreover, is supported by evidence obtained from the study of azide-catalase[4–6]. That a transient divalent state of catalase iron during normal catalatic activity has not so far been directly observed even by rapid flow methods may be due to an unusually high velocity of re-oxidation of this

ferrous catalase. In fact, the reaction of the primary catalase – hydrogen peroxide complex with further hydrogen peroxide results, according to Chance[7], in the formation of an "as yet undetermined complex which rapidly decomposes". It is probably within the very brief period of formation and decomposition of this complex, which is responsible for the catalatic decomposition of hydrogen peroxide, that valency changes of catalase iron take place.

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[1] Keilin, D., and Hartree, E. F., *Proc. Roy. Soc.*, B, **117**, 1 (1935).
[2] Haurowitz, F., *Z. physiol. Chem.*, **232**, 159 (1935).
[3] Barnard, R. D., private communication (1936).
[4] Keilin, D., and Hartree, E. F., *Proc. Roy. Soc.*, B, **121**, 173 (1936).
[5] Keilin, D., and Hartree, E. F., *Proc. Roy. Soc.*, B, **124**, 397 (1938).
[6] Keilin, D., and Hartree, E. F., *Biochem. J.*, **39**, 148 (1945).
[7] Chance, B., *Nature*, **161**, 914 (1948).

Partial Protection by Cortisone against Renal Lesions produced by Hypolipotropic Diets

A RELATIONSHIP has been shown between metabolic activity and the severity of lesions produced by feeding rats a diet low in choline and its precursors[1]. Cortisone (11-dehydro-17 hydroxycorticosterone acetate) is known to influence many metabolic processes[2], and it seemed possible that it might modify the effects of acute choline deficiency in weanling rats. Experiments have been carried out to study this possibility.

In four experiments a total of a hundred male rats of the Wistar strain, weighing 36–50 gm., were kept in individual metal cages, offered water *ad libitum*, and fed diets low in choline and its precursors, but otherwise adequate for good growth. In three experiments feeding was *ad libitum*; but in the fourth the animals were 'pair fed'. Fifty of the rats were given a daily subcutaneous injection of 0·5 or 1 mgm. of cortisone in saline. The remainder were injected with similar volumes of saline alone.

After eight days, all rats were sacrificed, and chemical and histological examinations were undertaken. Grossly, the kidneys of the controls were invariably swollen and "hæmorrhagic"[3], while those from the rats treated with cortisone varied in appearance from the normal to one indicating a lesion of moderate severity. Microscopically, the difference between the two groups was even more pronounced. The controls showed the renal changes expected, including subcapsular and cortical hæmorrhages, casts, and swelling of the tubular epithelium. The kidneys of the treated animals were frequently within the limits of normal; but in the majority of cases damage of a similar type but of a lesser degree than that in the controls was present.

In the *ad libitum* experiments the rats given cortisone ate more food (in one experiment 4·6 gm. compared with 3·0 gm. per day) and gained more weight (average gain of 1·4 gm. compared with average loss of 2·4 gm.) than the controls. The increased intake of the hypolipotropic diet, without cortisone, would have intensified the renal lesions. The deposition of excess liver fat was not affected by cortisone.

The mechanism and significance of this *partial* protection by cortisone against renal damage produced in young rats by choline deficiency are not apparent, and further investigations are in progress.

The cortisone was obtained from Merck and Company, Montreal, through a special grant from the National Research Council of Canada.

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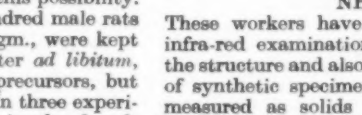
[1] Sellers, E. A., and You, Rosemary Wen, *Science*, **110**, 713 (1949).
[2] Hench, P. S., Kendall, E. C., Slocumb, C. H., and Polley, H. F., *Arch. Int. Med.*, **85**, 545 (1950).
[3] Griffith, W. H., and Wade, N. J., *J. Biol. Chem.*, **131**, 567 (1939).

Toxic Factor from Agenized Proteins: Infra-red Examination

As a result of detailed chemical investigations on the nature of the toxic factor produced by the action of nitrogen trichloride ('Agene') on flour, Bentley, McDermott, Pace, Whitehead and Moran[1] have isolated a compound with empirical formula $C_5H_{12}N_2O_3S$, which appears to be responsible for the toxicity. They have suggested that this compound is a derivative of methionine, with the probable structure (I).



(I)

These workers have supplied us with samples for infra-red examination, both as a possible check on the structure and also in order to establish the identity of synthetic specimens. The substances have been measured as solids suspended in paraffin or perfluorokerosene, using a Perkin Elmer 12 *C* spectrometer over the range 2–15 μ.

The spectrum of the toxic factor (*X*) is compatible with its being a derivative of an amino-acid, particularly near 6 μ and 3 μ, and with a weak band near 5 μ; but it has two strong bands near 1,000 cm.$^{-1}$ and 1,200 cm.$^{-1}$. It is already known[2] that sulphoxides give rise to a band near 1,000 cm.$^{-1}$, sulphones at 1,100 cm.$^{-1}$ and 1,300 cm.$^{-1}$, and we have now found a similar band with methionine sulphoxide and S-methyl cysteine sulphoxide. Further, it appears that the band in *X* near 1,000 cm.$^{-1}$ can be attributed to the S=N link, since it is found in the spectrum of synthetic $(CH_3)_2S\langle^{O}_{NH}$ and of synthetic preparations of methionine sulphoximine and S-methyl cysteine sulphoximine in which the S=O band lies near 1,200 cm.$^{-1}$. The possibility that these compounds have isomerized to form a compound analogous to the oximes $\rangle S{=}N{-}OH$ appears to be excluded on both chemical and spectroscopic grounds.

The toxic factor *X* was separated by the above workers into two fractions *A* and *B*, thought to be diastereoisomers, *A* being the more potent. The spectrum of *A* showed marked differences from that of *X*, but was identical with that of the synthetic sulphoximine from L-methionine. The spectrum of the sulphoximine made from DL-methionine differed

from that of *A* in small features of the kind expected of such isomers; but in several spectral regions it was unlike that of *B*, which resembled *X* very closely. This close similarity of *B* with *X*, and the relationship between *A* and *B*, are being examined further.

The spectra suggest that in some of these compounds where there is a long molecular skeleton, some of the main groups such as NH and C:O are affected by hydrogen-bridge formation, which varies according to the particular skeleton.

The main point is that the spectra support the suggestion that the sulphoximine of methionine is an essential part of the toxic factor. Details of this work will be published later elsewhere.

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[1] Bentley, McDermott, Pace, Whitehead and Moran, *Nature*, **163**, 675 (1949); **164**, 438 (1949); **165**, 150, 735 (1950).
[2] Barnard, Fabian and Koch, *J. Chem. Soc.*, 2442 (1949). Schreiber, *Anal. Chem.*, **21**, 1168 (1949).

Reduction in Lethal Effect of X-Radiation by Pretreatment with Thiourea or Sodium Ethane Dithiophosphonate

Dale *et al.*[1] showed that carboxypolypeptidase could be protected *in vitro* against X-radiation by a variety of substances. One of these, thiourea, is shown below to reduce the mortality following whole-body irradiation of mice. We also tried a few other substances, selected, like thiourea, in the hope that they would enter cells without being too toxic or too rapidly metabolized, and would protect by competing for hydroxyl radicals. The effect of sodium ethane-dithiophosphonate is of added interest because sodium ethane-monothiophosphonate protects weakly against the radiomimetic substance *bis*-chlorethyl sulphide (mustard gas)[2].

The irradiation technique will be described in fuller detail later. Mice of a *CBA* strain were used, irradiated in groups of four in the specially designed aluminium boxes in which they normally lived. The X-irradiation factors were: 240 kV. 15 m.amp. H.V.L. 1·14 mm. copper, tube distance 167·5 cm., dose-rate 7·59 r./min., dose measured inside cages containing bedding, food hopper and water bottle. By irradiating from below and inserting a stepped aluminium filter, a field uniform to within ± 3 per cent was achieved. Four boxes were irradiated at a time. Test substances were administered intraperitoneally in approximately isotonic solution a few minutes before or after irradiation, using saline as a control.

In experiment 1 a single dose of 875 r. was given. In experiment 2 a sublethal dose of 600 r. was given; three months later the injections were repeated and 875 r. was given. The accompanying table shows that the apparent protective effects of thiourea and dithiophosphonate were highly significant ($p \ll 0.01$) and of glycerol barely so ($p = 0.08$). It is also clear that thiourea given immediately after the irradiation was ineffective and that saline was not deleterious.

The *CBA* strain used responds very uniformly to radiation and, as judged by the slope of the dose-mortality curve in uninjected controls, the reduction in mortality in experiment 1 is equivalent to a reduction of only 10–15 per cent in the efficiency of the radiation, although the test substances were used in amounts not far from the maximum tolerated. In some circumstances radiation seemed to potentiate the toxic effects of thiourea.

A protective effect has been reported for cysteine[4], for glutathione[5] and for cyanide[6]; but the equivalent reduction in radiation efficiency was not stated.

We are grateful to the staff of the Unit for help with these experiments, and to its director, Dr. J. F. Loutit, for his interest and encouragement.

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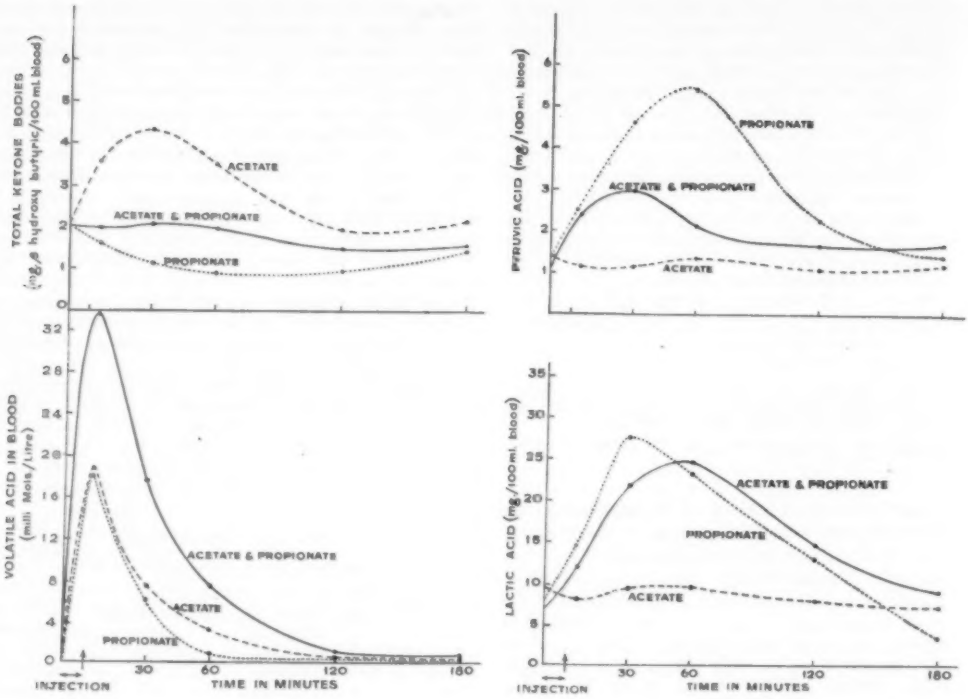
[1] Dale, W. M., Davies, J. V., and Meredith, W. J., *Brit. J. Cancer*, **3**, 31 (1949).
[2] Holiday, E. R., Philpot, J. St. L., and Stocken, E. L. (in preparation).
[3] Fisher, R. A., "Statistical Methods for Research Workers", p. 96 (10th edit., Oliver and Boyd).
[4] Patt, H. M., Tyree, E. B., Straube, R. L., and Smith, D. E., *Science*, **110**, 213 (1949).
[5] Chapman, W. H., Sipe, C. R., Eltzholtz, L. C., Cronkite, E. P., and Chambers, F. W., jun., Naval Medical Research Institute, National Naval Medical Centre, Bethesda, Ma., Project *NM* 006 012.08.25.
[6] Bacq, Z. M., Herve, A., Lecomte, J., and Fischer, P., *Science*, **111** 356 (1950).

Experiment	Age of mice at beginning of experiment	Sex	Material injected intraperitoneally	No. of mice	No. dying within 30 days	Mean number of days to death	Survival per cent	p for difference in mortality from group given saline*
1	9 weeks	Male only	2 ml. 0·15*M* saline before	20	18	11·8	10	—
			2 ml. 0·28*M* thiourea before	16	8	14·3	50	0·01
			2 ml. 0·28*M* thiourea after	12	12	11·0	0	—
			No injection	12	12	11·3	0	—
2	14 weeks	Male and female in equal numbers	2–3 ml. 0·15*M* saline	6	6	11	0	—
			2 ml. 0·28*M* thiourea	8	1	26	88	0·002
			3 ml. 0·1*M* sodium ethanedithiophosphonate	7	1	13	86	0·004
			2 ml. 0·28*M* glycerol	8	4	11½	50	0·08
			2 ml. 0·1*M* sodium thiosulphate	8	5	13	38	0·15
			3 ml. 0·1*M* sodium dithionate	8	8	14	0	—

* p was calculated by the exact method for 2 × 2 contingency tables (ref. 3).

Metabolism of Acetate and Propionate in the Ruminant

The volatile acids, acetic, propionic and butyric, which are formed by bacterial fermentation in the paunch of ruminants, assume an important role in the metabolism of these animals. In view of the relatively large amounts of acetate and propionate absorbed, the subsequent metabolic routes of these compounds are of considerable interest, not only from the aspect of the intermediary metabolism of each



individually, but also because of any possible interrelationships which may exist between them.

The concentrations of ketone bodies, of sugar, and of lactic and pyruvic acids were determined in the blood of sheep concurrently with those of the volatile fatty acids subsequent to the intravenous injection of 5 m.*M*/kgm. of acetic or propionic acids, or of a mixture of the two. The solutions used in these experiments were neutralized to *p*H 7·0 with caustic soda; the volume was 120 ml. for the individual acids and 240 ml. for the mixture.

The animals were kept in metabolism cages which reduced their activity to a minimum and yet permitted freedom of movement. A fine plastic tube (1 mm. internal and 1·7 mm. external diameter) was inserted for several inches into the jugular vein on the day preceding the experimental period, and a slow intravenous infusion of saline was maintained to reduce the possibility of blood clots occurring in the tube. Blood samples were obtained with a minimum of handling by attaching a syringe to the end of the tube. This allowed the animal to remain placid throughout the manipulations, a condition which is essential for such experiments as these, in which activity very materially influences the concentration of lactic and pyruvic acids in the blood.

After the pre-injection levels had been determined, the solutions were administered over a period of 5–10 min. Blood samples were then taken subsequent to the injection at 5, 30, 60, 120 and 180 min. Acetate was given on the first day of the experimental period and followed on successive days by the propionate, then the mixture, and occasionally by a hypertonic solution of saline.

The volatile acids were estimated by a modification of the method of Friedemann[1], the ketones by the method of Weichselbaum and Somogyi[2], the lactic acid by the method of Edwards[3], the pyruvic acid by the method of Friedemann and Haugen[4], and the sugar by the Somogyi method[5].

The diagrams illustrate the response of an animal typical of the others in the series. The tolerance curves for the volatile acids indicate that propionate is removed more rapidly from the blood stream than acetate. Concentrations of lactic and pyruvic acids and of sugar show that acetate alone was ineffective in causing any significant rise in these glucogenic intermediaries present in the systemic circulation. Propionate, however, did produce a marked increase in the blood levels of these substances; with the mixture of acetate and propionate, the levels were raised, but in the case of pyruvic acid to a lesser extent than with propionate alone.

The main interest in these observations centres around the ketone production. The ketogenic effect of acetate is evident from the increase in the ketone body concentration of the blood following its injection. The administration of propionate, however, brought about a reduction in the level of circulating ketones. The presence of the propionate in the equimolar mixture of acetate and propionate prevented the rise that normally would have followed the injection of the same amount of acetate unaccompanied by the propionate.

If the oxidation of fatty acids proceeds via the cyclophorase system[6], then it is likely that oxaloacetate, or one of its precursors, plays an important part in a condensation reaction with acetate or acetoacetate. The fact that propionate can lead to a rise in pyruvic acid, a known precursor of oxaloacetate, lends support to the suggestion that, in the ruminant, oxidation of acetate may be linked with

that of propionate. As the utilization of acetate is facilitated by the presence of pyruvic acid[7], the relatively limited supply of glucose available to the ruminant may then place greater stress on the concurrent supply and metabolism of propionate.

In view of our observations, the oxidation of acetate or acetoacetate may be impaired, with the possible development of ketosis, if the metabolism of propionate in the ruminant is in any way inhibited. Details of this experimental study will be published elsewhere.

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[1] Friedemann, T. E., *J. Biol. Chem.*, **123**, 161 (1938).
[2] Weichselbaum, T. E., and Somogyi, M., *J. Biol. Chem.*, **140**, 5 (1941).
[3] Edwards, H. T., *J. Biol. Chem.*, **125**, 571 (1938).
[4] Friedemann, T. E., and Haugen, G. E., *J. Biol. Chem.*, **147**, 415 (1943).
[5] Somogyi, M., *J. Biol. Chem.*, **160**, 71 (1945).
[6] Grafflin, A. L., and Green, D. E., *J. Biol. Chem.*, **176**, 95 (1948).
[7] Bloch, K., and Kramer, W., *J. Biol. Chem.*, **173**, 811 (1948).

Additional Transaminations by Insoluble Particle Preparations of Rat Liver

Braunstein and Kritzmann[1] suggested that transamination in pigeon breast muscle was a general reaction involving most of the amino-acids; Cohen[2] was unable to confirm these results, and pointed out the lack of experimental controls. Further work by Cohen[3] with purified enzyme preparations suggested that the transamination reactions were limited to

L-glutamate + oxalacetate ⇌ α-ketoglutarate + L-aspartate

and

L-glutamate + pyruvate ⇌ α-ketoglutarate + L-alanine.

Slower but significant reactions with other amino-acids have been shown to occur in kidney and liver homogenates by the same author[4]. Various workers[5–8] minimized these findings when assessing the general significance of transamination reactions.

Schoenheimer and colleagues[9] have shown that all but arginine and lysine, of many essential amino-acids investigated, interchange α-amino groups during protein turnover. Feeding experiments with α-keto and α-hydroxy analogues of many essential amino-acids have also clearly shown that the animal body possesses some mechanism for their amination, to form the corresponding amino-acids. (See Bubl and Butts for a short summary of these experiments[9].)

Accepting the current opinion of the limited scope of the transamination reaction, we set out to investigate the possibility that glutamine might, with a hydrogen donor, transfer its amide nitrogen to α-keto acids. As a guide for accurate work, paper chromatography[10] suggested itself as a convenient and approximately quantitative method for following the specific syntheses of amino-acids, by reactions of this type.

For the enzyme preparations, fresh rat liver was homogenized with two parts of ice-cold phosphate buffer, *p*H 7·8, and washed free of endogenous substrates by high-speed centrifugation. The sediment was made up to the original volume with buffer. 1 ml. of this preparation was incubated anaerobically at 37° C. for 30 min. with either *M*/20 glutamine or glutamate, and *M*/20 or *M*/40 α-keto acid, in a total volume of 2 ml. Proteins were then precipitated from the incubation mixtures by the addition of two volumes of warm ethanol. After centrifuging, the supernatant was evaporated to dryness *in vacuo* and taken up to the original incubation volume with water. For chromatography 1 μl. of this solution was used, and, with suitable solvents, runs of one to two hours were sufficient to effect a good separation of the amino-acids concerned.

Phenylpyruvic was used as the α-keto acid in the initial experiments. While a synthesis of phenylalanine occurred when glutamine was added with a hydrogen donor (coenzyme I and β-hydroxybutyrate), a much greater synthesis was achieved in the ammonium glutamate control experiment. Ammonium chloride, with added hydrogen donor, was not effective as an aminating agent in this system, whereas sodium glutamate was found to be just as effective as ammonium glutamate. This was taken as clear evidence that transamination from glutamate to phenylpyruvate does occur in rat liver. The tissue preparations used in these experiments showed strong glutaminase activity, and it would probably be through the intermediate formation of glutamate that glutamine brings about the amination of phenylpyruvate.

It was found that the glutamate–phenylpyruvate transaminase was located solely in the insoluble particle fraction of rat liver homogenates. Transamination to form tyrosine, alanine and aspartate was also catalysed by these particle suspensions. Mitochondrial preparations, obtained by differential centrifugation[11], were found to be active in pro-

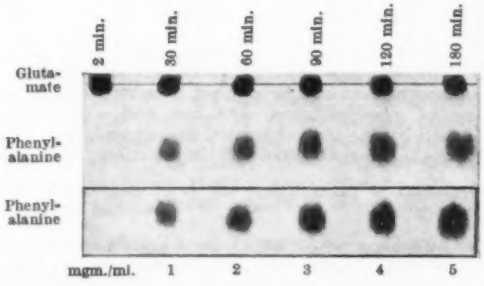

Fig. 1. Progress chromatogram showing phenylalanine synthesis from glutamate (*M*/20) and phenylpyruvate (*M*/20); separate chromatogram of known amounts of phenylalanine set underneath for comparison. Solvent system: collidine, water-saturated

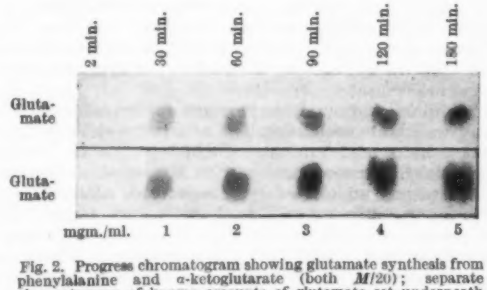

Fig. 2. Progress chromatogram showing glutamate synthesis from phenylalanine and α-ketoglutarate (both *M*/20); separate chromatogram of known amounts of glutamate set underneath for comparison. Solvent system: propanol water, 80/20

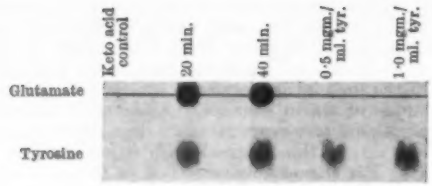

Fig. 3. Progress chromatogram showing synthesis of tyrosine from glutamate (*M*/20) and *p*-hydroxy-phenyl-pyruvate (*M*/40). Known amounts of tyrosine chromatographed on the same paper. Solvent system: collidine, water-saturated

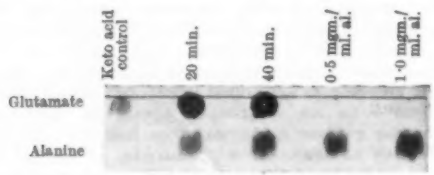

Fig. 4. Progress chromatogram showing synthesis of alanine from glutamate (*M*/20) and pyruvate (*M*/40). Known amounts of alanine chromatographed on the same paper. Solvent system: propanol water, 80/20

moting the syntheses of these four amino-acids by transamination, suggesting that the mitochondria may be the site of these reactions. The dialysed supernatant, on the other hand, catalysed transamination between glutamate, aspartate and alanine only. The rate of formation of phenylalanine in experiments with the insoluble fraction was found to be comparable with the rate of alanine formation in the soluble supernatant, both fractions of the homogenate being made up in the same volume.

It can be seen from the chromatograms (Figs. 1, 3 and 4) by comparisen with adjacent known amounts, chromatographed similarly, that a substantial synthesis of phenylalanine, tyrosine and alanine is catalysed by the insoluble particle preparations.

Progress chromatograms of the reaction

L-glutamate + phenylpyruvate ⇌ α-ketoglutarate + L-phenylalanine

show by comparison with adjacent known spots (run on paper in the same way) that the reactions are slow to reach equilibrium (Figs. 1 and 2). The half-way point (when there would be approximately 4 mgm./ml. of each reactant present) has not been reached either in the formation of glutamate or of phenylalanine. The formation of glutamate has also been shown to occur, qualitatively, by paper chromatography, when tryptophane, valine, leucine, histidine or glycine are each incubated with α-ketoglutarate in the presence of the insoluble particle preparations.

The particle-bound enzyme system revealed above may well be concerned in the amino-group exchange and α-keto acid amination which occur in intact animals[5-9]. Preoccupation with the soluble enzyme preparations which catalyse aspartate, alanine and glutamate amino-group exchanges has tended to divert attention from the more general transamination reactions of the cell, the existence of which is now confirmed.

We wish to thank Dr. M. Dixon and Dr. C. S. Hanes for their interest and advice during the course of this work. One of us (E. V. R.) wishes to acknowledge a grant from the Medical Research Council.

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[1] Braunstein, A. E., and Kritzmann, M. G., *Biochimia*, **3**, 590 (1938).
[2] Cohen, P. P., *Biochem. J.*, **33**, 1478 (1939).
[3] Cohen, P. P., *J. Biol. Chem.*, **136**, 565 (1940).
[4] Cohen, P. P., *J. Biol. Chem.*, **133**, xx (1940).
[5] Schoenheimer, R., "The Dynamic State of Body Constituents" (Cambridge, Mass.: Harvard University Press, 1946).
[6] Green, D. E., Leloir, L. F., and Nocito, V., *J. Biol. Chem.*, **161**, 559 (1945).
[7] Braunstein, A. E., *Adv. Protein Chem.*, **3**, 1 (1947).
[8] Cohen, P. P., *Fed. Proc.*, **1**, 273 (1942).
[9] Bubl, E. C., and Butts, J. S., *J. Biol. Chem.*, **180**, 839 (1949).
[10] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, **38**, 224 (1944).
[11] Hogeboom, G. H., Schneider, W. C., and Pallade, G. E., *J. Biol. Chem.*, **172**, 619 (1948).

Stabilization of Edible Fats by Condiments or Spices

Fortification of edible oils and fats against oxidation and rancidity is essential from the point of view of smell, taste and colour of the materials; further, oxidized and rancid oils have injurious physiological effects on the human system. For human consumption, refined oils are generally used; but they lose their natural antioxidants during processing. A difficulty in stabilizing edible fats is that, except for a few substances such as N.D.G.A., lecithin, tocopherols, kamla dye and oat flour, most antioxidants are toxic. N.D.G.A. is very sparingly soluble in oils and kamla dyes fat orange.

From very early times in India it has been customary to add to edible fats, especially rendered butterfat (ghee), such spices or condiments as garlic and red chillies. In the preparation of pickles, the oils are added after heating them to incipient charring with small quantities of red chillies, fennel, asafœtida, caraway or cloves.

It is of interest to find out whether the use of such substances has a scientific justification in stabilizing edible oils and fats. Refined groundnut oil was heated with definite amounts of spices or condiments up to 275–280° C. so that charring occurred. The oil was then cooled and filtered. The material was subjected in each case to the 'swift stability test' at 100° C., the oxidation period being five hours in each case. The peroxide and acid values of these oils were compared with those of the original oils and with those of similarly heated oils without addition, all being submitted to the oxidation test. The accompanying results demonstrate that spices and condiments are actually effective preservatives for refined groundnut oil. This is seen by the low peroxide and acid value as compared with those of the control, 76·9 and 0·99 respectively.

As was expected, heating the oil at 275° C. decomposed some of the peroxides. The oils so treated, with the addition of spices, were found to have no perceptible taste or odour.

Thus once more an age-old custom of mankind is now found to have a sound scientific basis.

Spice or condiment	Quantity used (%)	Peroxide value	Acid value
Original oil before any treatment	—	7·05	0·51
Oil after aeration	—	100·50	1·05
Oil heated to 275° C.	—	1·20	0·41
Oil heated to 275° C. and aerated (control)	—	76·90	0·99
Red chillies	0·50	23·40	0·58
	1·00	12·50	0·47
	1·50	7·10	0·44
Green chillies	2·00	16·10	0·54
	3·00	13·80	0·50
	5·00	11·80	0·43
Cinnamon leaves	0·50	12·80	0·52
	1·00	8·50	0·51
	1·50	7·50	0·50
Cinnamon bark	0·50	31·30	0·45
	1·00	20·60	0·44
	1·50	16·70	0·44
Dry ginger	0·50	19·80	0·51
	1·00	14·40	0·50
	1·50	9·90	0·48
Green ginger	2·00	26·10	0·52
	3·00	16·20	0·45
	5·00	12·50	0·43
Tumeric	0·50	25·20	0·47
	1·00	15·10	0·35
	1·50	9·50	0·32
Nutmeg fruit	0·50	20·10	0·63
	1·00	13·10	0·52
	1·50	10·70	0·50
Nutmeg mace	0·50	35·00	0·50
	1·00	15·30	0·46
	1·50	11·80	0·44
Black pepper	0·50	45·20	0·60
	1·00	12·30	0·51
	1·50	10·50	0·48
Cloves	0·50	66·70	0·70
	1·00	16·40	0·55
	1·50	15·70	0·49
Onions	2·00	23·30	0·56
	3·00	17·70	0·45
	5·00	15·60	0·41

Tests with other edible oils and fats, such as sesame, mustard, safflower, and butter-fat (ghee), are in progress. The keeping qualities of these stabilized fats over long periods of time are also being further studied.

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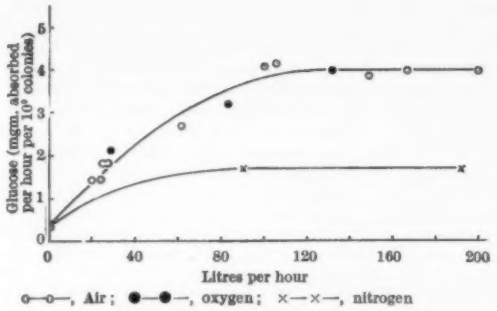
Effect of Aeration on the Absorption of Glucose by a Green Alga

It has recently been shown that aeration of the culture medium brings about increased growth of bacteria[1] and of excised roots[2]. During an investigation of the factors affecting the absorption of glucose by the green alga *Scenedesmus quadricauda*, it was noticed that aeration of the medium resulted in a considerably greater uptake of glucose.

Bacteria-free cultures of *Scenedesmus quadricauda* were grown in an autotrophic culture medium (medium *C* of Österlind[3]) at 25° C. under a constant light intensity of 150 foot-candles supplied by daylight fluorescent tubes. The cultures were centrifuged after eight or nine days growth and suspended in *M*/30 phosphate buffer at *p*H 5·5. 5 ml. of this suspension was introduced into a long black 'Pyrex' tube sealed at one end and immersed in a water bath at 25° C. Air was blown through the suspension through a porcelain bubbler at the bottom of the tube. After half an hour's aeration, to bring the suspension to equilibrium, 1 ml. glucose solution was added and the aeration continued for another two hours. The tube was then washed out into a filter crucible, and the filtrate analysed for glucose by the method of Hanes[4]. In order to reduce evaporation from the suspension, the air was passed through a wash-bottle containing distilled water before entering the tube. The number of four-celled colonies present in the medium was taken as the basis for computing the rate of absorption since this is proportional to the surface area, the most important factor in absorption. The number of colonies in an aliquot of the original suspension was determined by counting at least two hundred colonies in at least three drops.



The effect of different rates of aeration on the rate of absorption of glucose is shown in the accompanying figure. Up to an aeration-rate of about 100 litres per hour, an increase in the rate of aeration results in an increase in the rate of glucose uptake; but above this, the rate of glucose absorption is independent of the rate of aeration, remaining constant at $3{\cdot}93 \pm 0{\cdot}17$ mgm. glucose per hour per 10^8 colonies. The slope of the first part of the curve can be altered by using different aerating conditions. For example, the rate of glucose uptake increased much more slowly with increase in the rate of aeration when a plain glass tube with no bubbler attached was used, though the limiting value for the rate of glucose absorption was the same under both conditions.

The beneficial effects of the aeration might be due to the oxygen tension in the solution, since Pearsall and Bengry[5] have reported that the rate of oxygen uptake of *Chlorella* in an unshaken Warburg manometer is independent of the number of cells in the suspension, and is only one-eighth of the uptake on shaking. It is possible, therefore, that the uptake of glucose is dependent on the oxygen available for respiration. On the other hand, the increase may simply be due to the fact that aeration causes mechanical agitation of the cells in the glucose solution, enabling the cells to receive a greater supply of glucose than when they are stationary on the bottom of the tube. Experiments using pure oxygen, however, showed no significant differences from the corresponding rates in air, suggesting that oxygen tension of the solution is not the main factor determining the rate of uptake of glucose. A very low rate of glucose uptake is possible under static conditions, presumably due to the absorption of glucose by the uppermost layer of algæ.

That the presence of oxygen does have an effect on the absorption of glucose can be seen by determin-

ing the rate when nitrogen is bubbled through the suspension. Under these conditions the rate of uptake is much lower than with air or oxygen. Thus although aeration has its main effect through mechanical agitation, the absence of oxygen results in a considerable lowering of the rate of glucose uptake.

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[1] Roberts, R. S., *Nature*, **165**, 494 (1950).
[2] Brown, R., and Sutcliffe, J. F., *J. Exp. Bot.*, **1**, 88 (1950).
[3] Osterlind, S., *Symb. Bot. Upsaliensis*, **10**, No. 3 (1949).
[4] Hanes, C. S., *Biochem. J.*, **23**, 99 (1929).
[5] Pearsall, W. H., and Bengry, R. P., *Ann. Bot.*, N.S., **4**, 485 (1940).

A Probable Deletion in a Human *Rh* Chromosome

A SAMPLE of blood sent to us because of the presence of most unusual antibodies has proved, on investigation, to have even more extraordinary *Rh* antigens. The blood is unique in our experience, and in the literature, in that it has the antigen *D*, but lacks any detectable representative of the *C* and *E* allelomorphic series of antigens.

The donor of the blood is homozygous for this deficiency, owing without a doubt to her parents being half second cousins. Her mother is heterozygous for the condition; her father and two brothers are dead.

The genotype of the donor may be written —*D*—/—*D*—, the dashes representing the absence of *C*, *c*, C^w, c^u, C^u and the absence of *E*, *e*, E^u. The absence of these antigens was demonstrated by negative results of agglutination tests in saline and in albumin, of indirect anti-globulin tests, of trypsin tests and of absorption tests. The presence of an abnormal amount of the *D* antigen was demonstrated by the much greater power of the —*D*—/—*D*— blood to absorb anti-*D* compared with that of *CDe*/*cDE* blood; it was also shown in comparative tests with *CDe*/*cDE* and *cDE*/*cDE* cells against titrations of incomplete anti-*D* in albumin; it was shown most strikingly of all by the unique ability of the cells to be agglutinated in saline by incomplete anti-*D* (which, incidentally, makes it almost certain that this antibody is not monovalent as it has so often been represented). The somewhat extensive serological details will be recorded elsewhere. Nothing abnormal was found in the other blood groups of the donor.

In the serum of the donor we have so far been able to identify anti-*e*, anti-*C* and anti-*c*. The finding of both anti-*C* and anti-*c* in one serum is extraordinary but not altogether unexpected in a person lacking any *C* or *c* antigens.

Three possible genetic interpretations suggest themselves:

(1) The *C* and *E* loci may be represented by unknown, silent allelomorphs. This is unlikely, for all the known allelomorphs produce antigens which are easily detectable; it is highly improbable because two of this new kind of allelomorph, one at the *C* and the other at the *E* locus, would have to be postulated on the same chromosome.

(2) A suppressing gene may be at work. It is difficult to imagine that such a gene would suppress all activity at the *C* and *E* loci yet not at the *D* locus. Moreover, the presence of *C* or *c* antigens, even when suppressed, would surely be incompatible with the existence in the serum of both anti-*C* and anti-*c*.

(3) Deletion of a portion of the *Rh* chromosome seems to offer the most satisfying explanation. It would fit well with the total absence of the *C* and *E* antigens and might explain the exalted *D* antigen. We have for some time had evidence that suggests that a common basic material of limited amount is available for the production of the *C D E* antigens. Freed from the competition of *C* and *E*, *D* might take all such hypothetical raw material. That the deletion is probably a short one is suggested by the good health of the donor and by the absence of any other congenital abnormality.

Whatever the exact genetic mechanism, the fact that *C* and *E* are involved supports from an unexpected angle Fisher's tentative suggestion[1] that the order of the genes on the chromosome would be found to be *D C E*. It also seems that the very controversial question whether the genes are separable or not is settled in the most convincing way of all—by their separation.

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[1] Fisher, R. A., and Race, R. R., *Nature*, **157**, 48 (1946).

Separation and Identification of Sugars using Paper Chromatography

CHROMATOGRAPHY on filter paper has provided an excellent and a much-needed method for the investigation of the structure of polysaccharides[1-5] and proteins[6-10]. While butanol–ethanol–water, butanol–acetic acid–water, and phenol–water are effective mixtures, among others[1], for the separation of a wide variety of sugars[11,12,5] and their methyl derivatives[13], the phenol–water mixture is usually better than either of the other two mentioned above for the separation of unmethylated sugars (cf. ref. 14). The method using phenol–water, however, suffers from the disadvantage that the location of the sugars on the paper by treatment with ammoniacal silver nitrate cannot be accomplished without some difficulty because the paper quickly becomes dark or sometimes black. It is claimed that suitable purification of the phenol either reduces the darkening[5] or eliminates it altogether[15]. We find that most of the darkening can be avoided by extracting the paper with ether before spraying with the silver reagent. By adopting this slight modification, it has been found unnecessary to purify the phenol.

The use of either malonic acid (10 gm.) or propionic acid (10 ml.)[16] in conjunction with butanol (40 ml.) and water (50 ml.) as partitioning solvents has also been shown to avoid the over-all blackening of the paper produced by spraying with the silver reagent and subsequent heating.

Experiments with either of these mixtures are allowed to proceed for 20–25 hr. at about 25° C., after which the paper (Whatman No. 1) is dried in the air and then for 10–15 min. at 100° C. The sugars can then be detected with the ammoniacal silver reagent. When malonic acid is used, it is advisable to extract excess of it with ether after the initial drying and heating at 100° C., otherwise the sensitivity of the silver test is reduced. It is of interest to note that malonic acid prevents spreading of the sugar zones.

When malonic acid is used in the developing solvent, non-reducing oligosaccharides such as sucrose, melizitose and raffinose containing a labile glycosidic bond undergo hydrolysis during the heating at 100° C.; their positions on the paper are then revealed by the cleavage fragments showing a positive test with the ammoniacal silver reagent (cf. refs. 17, 2, 5). Glucose-1-phosphate, likewise sensitive to acid, can also be detected in the same way. The labile non-reducing sugars are not detectable with the butanol–water–propionic acid solvent because the propionic acid is not capable of effecting the necessary hydrolysis; but if the paper is dried and sprayed with the upper layer of the malonic acid–butanol–water mixture and heated at 100°, the non-reducing sugars undergo hydrolysis and their reducing cleavage fragments can be detected. This procedure has also enabled us to detect sucrose, melizitose and raffinose after separation with phenol–water.

In investigating the structure of polysaccharides, we have found methyl-ethyl-ketone saturated with water to be an excellent solvent for the partition chromatography of methylated sugars. This solvent appears to be somewhat better than butanol–ethanol–water[3] and it also has the advantage that its movement on filter paper and columns of cellulose is relatively rapid. Thus it gives a good separation of the 2, 3, 4, 6-tetramethyl glucose, 2, 3, 6-tri- and 2, 3-dimethyl derivatives of D-glucose, the R_F values of which are 0·82, 0·56 and 0·28 respectively. The mixture of the cleavage fragments of many methylated galactomannans, namely, 2, 3, 4, 6-tetramethyl-D-galactose (R_F, 0·68), 2, 3, 6-trimethyl-D-mannose (R_F, 0·50), and 2, 3-dimethyl-D-mannose (R_F, 0·22) can also be resolved with relative ease.

Successful separations of methylated sugars can also be achieved by using the upper layer of a mixture of 90 per cent methyl-ethyl-ketone and 10 per cent petroleum ether (b.p. 100–120° C.) saturated with water. Diethyl ketone saturated with water can also be used.

While many of the partially methylated reducing sugars can be detected by the ammoniacal silver nitrate test, the more highly methylated reducing sugars do not give a good reaction. To overcome this difficulty, the paper may be sprayed with a solution containing the salt of an aromatic base and then heated at 100–130° C. The following bases have been found useful: (*a*) aniline, (*b*) amino-dimethyl benzene, (*c*) *p*-phenylene diamine, (*d*) *p*-amino-dimethyl aniline, (*e*) *p*-amino-diethylaniline and (*f*) N (1-naphthyl)-ethylene-diamine. Of these (*d*) and (*e*) are particularly effective, inasmuch as the colours produced depend not only on the degree of methylation, but also upon the position of the methyl group (cf. refs. 18, 19). Methyl derivatives of ketoses are readily located by (*f*). We have found that hydrochloric, formic, trichloracetic and toluene sulphonic acid may be used in conjunction with the above bases. Such sprays containing salts of aromatic bases will readily locate free sugars, the non-reducing sugars such as sucrose, raffinose and melizitose and certain glycosides.

All the free sugars and some polyhydric alcohols such as sorbitol, mannitol and inositol can be detected by spraying with a solution of silver oxide in ammonia, followed by washing with ammonium hydroxide.

Paper partition chromatographic studies of the dimethyl glucose fragment of methylated rabbit liver glycogen has revealed that it contains two dimethyl sugars, one of which is the well-known 2 : 3 dimethyl-D-glucose (cf. ref. 2). It would thus appear that if the polysaccharide is fully methylated and if no demethylation occurs during methanolysis, at least one other linkage besides the 1 : 4 and the 1 : 6-types is present in glycogen[20]. Similar studies have also enabled us to show that the xylan of wheat straw and of corn cobs contains arabinose units in addition to those which occupy terminal positions; glucose was also identified. By making use of the fact that 2, 3, 4-trimethyl-D-xylose gives a red-brown colour and 2, 3, 5-trimethyl-L-arabinose a bluish-black colour with the *p*-amino-dimethylaniline reagent, it has also been shown that terminal xylose units as well as terminal arabinose units are present in these two so-called xylans.

These results would appear to indicate that the structure of xylan as revealed by methylation studies[13] is in need of revision. The arabinose units other than those which occupy terminal positions may arise from hitherto unrecognized building units of the xylan molecule, or from an araban-like polysaccharide which is either in admixture or in combination with the xylan molecule. The identification of terminal xylose residues, however, suggests that, in the case of xylan, we must return to the former view[21] that this polysaccharide is structurally related to cellulose and consists of long chains of xylopyranose units, joined by 1 : 4-β-linkages.

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[1] Chargaff, E., Levine, C., and Green, C., *J. Biol. Chem.*, **175**, 67 (1948).
[2] Cf. Hirst, E. L., Hough, L., and Jones, J. K. N., *J. Chem. Soc.*, 928 (1949).
[3] Hough, L., Jones, H. K. N., and Wadman, W. H., *Nature*, **162**, 448 (1948); *J. Chem. Soc.*, 2511 (1949).
[4] Pascu, E., Mora, T. P., and Kent, P. W., *Science*, **110**, 446 (1949).
[5] Partridge, S. M., and Westhall, R. G., *Biochem. J.*, **42**, 238 (1948).
[6] Bentley, H. R., and Whitehead, J. K., *Nature*, **164**, 182 (1949).
[7] Bull, H. B., Hahn, J. W., and Baptist, V. H., *J. Amer. Chem. Soc.*, **71**, 550 (1949).
[8] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, **38**, 224 (1944).
[9] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, **41**, 590 (1947).
[10] Franklin, A. E., and Quastel, J. H., *Science*, **110**, 447 (1949).
[11] Flood, A. E., Hirst, E. L., and Jones, J. K. N., *J. Chem. Soc.*, 1679 (1948).
[12] Partridge, S. M., *Nature*, **158**, 270 (1946).
[13] Haworth, W. N., Hirst, E. L., and Oliver, Elsie, *J. Chem. Soc.*, 1917 (1934). Bywater, R. A. S., Haworth, W. N., Hirst, E. L., and Peat, J., *ibid.*, 1983 (1937).
[14] Jermyn, M. A., and Isherwood, F. A., *Biochem. J.*, **44**, 402 (1949).
[15] Draper, O. Janet, and Pollard, A. L., *Science*, **109**, 448 (1949).
[16] Cf. Benson, A. A., and Calvin, M., *Science*, **109**, 140 (1949).
[17] Forsyth, W. G. C., *Nature*, **161**, 239 (1948).
[18] Hirst, E. L., Hough, L., and Jones, J. K. N., *Nature*, **165**, 34 (1950).
[19] Partridge, S. M., *Nature*, **164**, 445 (1949).
[20] Bell, D. J., *Angew. Chem.*, **60A**, 79 (1948).
[21] Hampton, H. A., Haworth, W. N., and Hirst, E. L., *J. Chem. Soc.*, 1739 (1929).

Use of Paper Partition Chromatography in the Identification of the Volatile Fatty Acids

THE volatile fatty acids are important in many biological processes. They may be separated, identified and estimated by means of partition chromatography using silica gel columns. The whole range from acetic to capric acids, inclusive, may be separated in this way; but this involves the use of more than one solvent[1,2] (that is, separation in stages) or buffered columns[3], and several titrations.

Lugg and Overell[4] separated organic acids as the free acids on paper sheets, using a mixture of butanol and acetic acid as the mobile phase, a method inapplicable, however, to the volatile fatty acids. Fink and Fink[5] described a method in which the hydroxamates of the methyl esters of the volatile fatty acids were run on paper and developed with ferric chloride. Boldingh[6] has run the ethyl esters of the fatty acids on paper strips coated with rubber and developed the spots with Sudan IV solution.

We have successfully used the method described below for the quick identification and rough estimation of the volatile fatty acids in culture fluids and cheese distillates. This method was based primarily on the silica gel technique of Lester Smith[7] and Elsden[8], in that water was used as the stationary phase, butanol as the mobile phase and brom-cresol-green as the indicator, which was sprayed on the paper as a 2 per cent solution in alcohol after the butanol had been driven off in a current of cool air.

The free fatty acids could not be used because of volatilization during the running of the chromatogram, neither could the sodium salts, because they remained stationary. Volatile weak alkalis were tried in the hope of controlling the ionization of the acids by varying the concentration of alkali, and although this was not achieved, satisfactory chromatograms were obtained by using ammonia or ethylamine in the vapour phase.

Chromatograms so prepared remained alkaline to brom-cresol-green even after an exposure of half an hour to the atmosphere; but on a further exposure of one to several hours the blue colour of the background gradually changed to greenish-yellow, while the spots representing the acids remained blue for at least several days. Eventually they, too, faded. We have not examined the reasons for this delayed development; but acidification by atmospheric carbon dioxide at a rate depending on the buffering power of the substances in the paper seems a plausible explanation.

The volatile fatty acids do not differ greatly in strength. For example, acetic, butyric and caproic acids were found to be completely titrated with ethylamine before the *p*H had risen to 6. As there is an excess of the volatile alkali during chromatography and the *p*H is well above 6, the fatty acids in the aqueous phase will exist as anions. Thus the concentration of the alkali is not critical; if the fatty acids are neutralized (to brom-cresol-green) with ethylamine before testing, a very low concentration of the vapour may be used, with the advantage that, on spraying, the blue spots develop at once on a bright yellow background and the contrast is greater than that obtained by allowing a blue chromatogram to fade. Brom-cresol-purple can replace brom-cresol-green as developer, but the spots are less vivid. We have used ethylamine in preference to ammonia as the volatile alkali, since it gives more durable and more clearly defined spots. The spots are not permanent, but the colour contrast in the fresh chromatograms is sufficiently good to give permanent photographic records. Typical R_F values are shown in the accompanying table.

Fatty acids (N/10)	R_F values (room temperature)	
	Ammonia	Ethylamine
Acetic	0·11	0·20
Propionic	0·18	0·31
Butyric	0·28	0·44
Valeric	—	0·56
Caproic	0·67	0·77
Caprylic	0·81	0·91
Capric	0·84	—
Lauric	0·87	—

As with the amino-acids, the area of the spot gives a rough indication of the total quantity of fatty acid present; 4 γl. of N/10 solutions give convenient but rather large spots, N/100 is a better concentration and N/1,000 is just detectable.

Since this letter was written, a communication from F. Brown and L. P. Hall has appeared (*Nature*, July 8, p. 66) describing a method which, though similar in some respects to the one we have described, gives yellow spots on a pale blue background. Presumably, the yellow spots indicate free acids liberated by the decomposition of the ammonium salts during the heating at 95° C., primarily intended for the evaporation of the solvent. In our method the solvent is allowed to evaporate at room temperature and the ammonium or ethylamine salts do not decompose but, remaining in the water associated with the cellulose, give a solution alkaline to brom-cresol-green, and therefore appear as blue spots on the chromatogram. The loss of volatile acids is thus reduced to a minimum, and the method gives roughly quantitative results.

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[1] Ramsay, L. L., and Patterson, W. L., *J. Assoc. Off. Agric. Chem.*, **31**, 139, 441 (1948).
[2] Peterson, M. M. H., and Johnson, M. J., *J. Biol. Chem.*, **174**, 775 (1948).
[3] Moyle, V., Baldwin, E., and Scarisbrick, R., *Biochem. J.*, **43**, 308 (1948).
[4] Lugg, J. W. H., and Overell, B. T., *Nature*, **160**, 87 (1947).
[5] Fink, K., and Fink, R. M., *Proc. Soc. Exp. Biol. and Med.*, **70**, 654 (1949).
[6] Boldingh, J., *Recueil*, **69**, 247 (1950).
[7] Lester Smith, E., *Biochem. J.*, **36**, *Proc.* xxii (1942); also private communication (1942).
[8] Elsden, S. R., *Biochem. J.*, **40**, 252 (1946).

Differential Phase Change at Reflexion

THE measurement of length by interferometry can only be made with the highest precision if corrections are applied for the differential phase changes produced at reflexion at the relevant surfaces. These corrections are very small, and their magnitude and relation to surface structure can best be studied by multiple-beam interferometry.

The phase change at reflexion at a surface appears to be a function of both the material and the surface finish. From measurements made on the height of steps etched in a polished glass surface, it was found that a small differential phase-change effect occurred due to the difference in surface roughness of the polished surface of the glass and the etched bottom of the step. For these measurements, the surface of

the glass had been coated by vacuum evaporation with a 94 per cent reflecting layer of silver, and used as one plate of a multiple-beam interferometer.

The expressions[1] for the reflected and transmitted intensities in a multiple-beam interference system consisting of two plates, 1, 2, with reflexion coefficients R_1 and R_2 and transmission coefficients T_1 and T_2 respectively, are as follows:

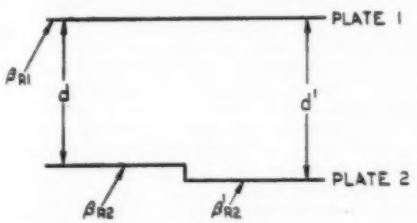
$$I_R = R_1 + \frac{T_1^2R_2 + 2R_1^{1/2}R_2^{1/2}T_1\cos(\Delta+F) - 2R_1R_2T_1\cos F}{1 - 2R_1^{1/2}R_2^{1/2}\cos\Delta + R_1R_2} \quad (1)$$

$$I_T = \frac{T_1T_2}{1 - 2R_1^{1/2}R_2^{1/2}\cos\Delta + R_1R_2}, \quad (2)$$

where $\Delta = \frac{4\pi d}{\lambda} - \beta_{R1} - \beta_{R2}$; β_{R1}, β_{R2} are phase changes at reflexion at surfaces 1, 2 respectively; $F = -2\beta_{T1}$; β_{T1} is phase change on transmission through plate 1; d is separation of plates; and λ is wave-length of light. From the conditions of maxima and minima it follows that

$$\frac{4\pi d}{\lambda} - \beta_{R1} - \beta_{R2} = 2n\pi + f(R_1, R_2, T_1, \beta_{T1}) \quad \text{(reflected system)} \quad (3)$$

and $$\frac{4\pi d}{\lambda} - \beta_{R1} - \beta_{R2} = 2n\pi \quad \text{(transmitted system)}. \quad (4)$$



If now one of the plates of the system is made up of two parts, as shown in the diagram, one part producing a phase change of β_{R2} and the other of β'_{R2}, the separation of the first part being d and of the second d', then it follows from both (3) and (4) that

$$\frac{\lambda}{4\pi}(\beta_{R2} - \beta'_{R2}) = (d - d') - \frac{\lambda}{2}(n - n'), \quad (5)$$

where $(d - d')$ is true height of step in second plate; $\frac{\lambda}{2}(n - n')$ is measured value of step-height from fringes at wave-length λ; $\frac{\lambda}{4\pi}(\beta_{R2} - \beta'_{R2})$ is differential phase-change effect at wave-length λ. n, n' will, in general, not be integral.

If the height of the step is measured at two wave-lengths, λ_1 and λ_2, it follows that

$$\frac{\lambda_1 - \lambda_2}{4\pi}(\beta_{R2} - \beta'_{R2}) = \frac{\lambda_2}{2}(n_2 - n'_2) - \frac{\lambda_1}{2}(n_1 - n'_1), \quad (6)$$

where n_1, n'_1 and n_2, n'_2 correspond to values for λ_1 and λ_2 respectively.

Equation (6) then enables the differential phase-loss $(\beta_{R2} - \beta'_{R2})$ to be found from the measurement of the height of the step by multiple-beam interference fringes. Substitution in equation (5) then gives the phase-change effect at any wave-length.

This was done in the case of the etched steps in a polished glass surface, using Fizeau fringes. It was found that a change in wave-length from 4000 A. to 6000 A. produced a change in the measured height of a step of the order of 40 A. This gave a value of 14° for the differential change in phase angle, or a value of 109 A. for the differential phase-change effect at a wave-length 5461 A. As the surfaces of both the top of the glass and the bottom of the step were coated identically with a silver layer, this small differential effect could only be due to the difference between the surface structure or roughness of the etched surface and of the polished surface.

The accuracy obtained for a single height measurement was 9 A., but the overall accuracy of the determination of the phase-change effect was less than this, due to variations in etching properties of the glass from point to point. The measured change in height was therefore probably 40 A., but not greater than 80 A.

The differential phase-change effects for various metals and non-metals are now being measured by this multiple-beam interference method. Of particular interest in the measurement of length by interferometry are the phase-change effects produced with lapped surfaces of steel, chromium and glass.

This work has been carried out as part of the research programme of the Division of Metrology, Commonwealth Scientific and Industrial Research Organization.

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[1] Holden, J., *Proc. Phys. Soc., Lond.*, B **62** (7), 405 (1949).

Deformations in the Crystal Structures of Anti-ferromagnetic Compounds

It has been shown that slight deformations occur in the crystal structures of various oxides of the iron group. B. Ruhemann[1] has found that there is a very slight change in the crystal structure of MnO near 120° K. Rooksby[2] and Tombs and Rooksby[3] have reported that the face-centred, cubic arrangements in MnO, FeO, CoO and NiO show changes to tetragonal or rhombohedral symmetry upon cooling through a transition temperature.

The four compounds mentioned above are all known to be antiferromagnetic[4]. We should like to point out that the temperatures at which the deformations occur are apparently the antiferromagnetic Curie temperatures, as indicated by the data in the following table.

Compound	Magnetic transition temperature[4]	Structure transition temperature	
MnO	122° K.	120° K.	[1]
FeO	198	203	[2]
CoO	271	200–300 267–281	[3]
NiO	~500	~170	[1]
Cr_2O_3	311	307–18	

In order to check this hypothesis further, we have made X-ray photographs of CoO and Cr_2O_3 (another antiferromagnetic compound) near their Curie temperatures. A symmetric-focusing back-reflexion camera was modified so that exposures could be taken over a temperature range of 230–350° K. The

change from cubic to tetragonal symmetry reported by Tombs and Rooksby for CoO was observed. A broadening of the 331 reflexion was perceptible at 281° K. Just below the Curie temperature, at 267° K., the reflexions from the (331) and (313) planes were completely resolved.

The Curie temperature of Cr_2O_3 has been reported as 305° K. and 320° K. by different investigators[4]. Susceptibility measurements made by Dr. T. R. McGuire of this Laboratory indicate that the Curie temperature of the particular sample used here was 311 ± 2° K. The normal crystal structure class of Cr_2O_3 is D_3^6d. A change in structure first becomes apparent as a very slight broadening of the $42\bar{2}$ reflexion at 318° K. At 307° K. the line is a doublet and the separation increases rapidly as the temperature is lowered.

These results can be understood qualitatively in the following way. There are two conditions necessary for antiferromagnetism. First, the crystal structure must be such that the magnetic atoms can be divided into two interpenetrating sub-lattices with atoms on sub-lattice A having nearest neighbours only on sub-lattice B, and vice versa. The exchange integral, J, between neighbouring magnetic atoms must be negative so that antiparallel spin orientations are preferred. For such conditions, the state of lowest magnetic energy is that in which all the A atoms point in one direction and all the B atoms point in the opposite direction. For any finite temperature this complete ordering will be somewhat disturbed by thermal agitation. The effective potential energy of a particular magnetic atom, due to the exchange interactions, is approximately $-2z'|J|S^2$, where z' is the net number of nearest neighbours with spins oriented antiparallel to the spin of the given atom. S is the total spin quantum number of a single atom. In general, J will be a function of interatomic separation, r. The effect of the exchange interactions, besides producing alignment, will be to move the atoms so as to increase $|J|$ and thus deepen the magnetic energy-levels. Consequently the magnetic atoms should be pulled closer together or pushed farther apart, depending on the sign of dJ/dr. Since the value of z' increases with decreasing temperature, we should expect that the deformation would also increase with decreasing temperature. Such an effect was observed by Rooksby and by us.

Arguments similar to the above have been used to explain the thermal expansion properties of ferromagnetic materials[5].

At present, we are not able to give a detailed interpretation of the crystal structure changes in terms of the exchange couplings between the magnetic atoms. When such an interpretation is available it should give valuable information concerning the exchange (and super-exchange) interactions in antiferromagnetic compounds.

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[1] Ruhemann, B., *Phys. Z. U.S.S.R.*, **7**, 590 (1935).
[2] Rooksby, H. P., *Nature*, **152**, 304 (1943); *Acta Cryst.*, **1**, 226 (1948).
[3] Tombs, N. C., and Rooksby, H. P., *Nature*, **165**, 442 (1950).
[4] Bizette, H., *Ann. Physique*, **1**, 300 (1946). Foëx, M., and LaBlanchetais, C. H., *C.R. Acad. Sci., Paris*, **228**, 1579 (1949).
[5] Shockley, W., *Tech. Pub. Bell Tel. System*, **13**, 645 (1939). Bozorth, R. M., *ibid.*, **19**, 1 (1940).

Frictional Electrification and Gaseous Discharge

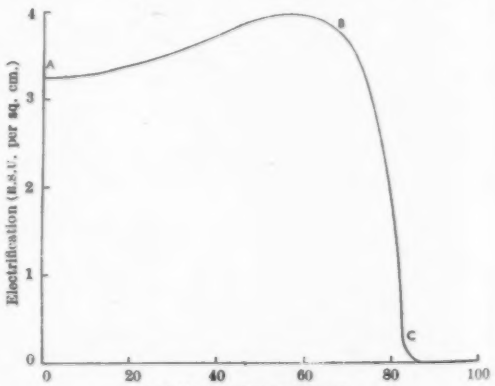
It is well known that the leakage of charge from high-voltage static generators, such as the Van de Graaff machine, is controlled by use of high pressure or other suitable atmospheres which increase the dielectric strength of the medium in which they operate. The results reported below suggest that in a study of the mechanism of frictional electrification, quantitative measurements may be of doubtful value, because a similar leakage is apt to take place between the rubbing surfaces and to control the process of charge separation.

It has been found that the frictional electrification of some clean hygroscopic polymers is critically dependent on moisture concentration above a certain humidity. Below this humidity, or with a non-hygroscopic substance, electrification is limited by gaseous discharge between the rubbing surfaces.

The experiments which showed this effect consisted of drawing a wool fibre over a metallic cylinder (for example, a platinum wire) by means of an insulated rod, the potential generated upon the metallic cylinder being measured by a Lindemann electrometer. The apparatus was totally enclosed in a metal box, and the effects upon electrification of humidity, load, and speed of rubbing were investigated.

The quantity of charge produced per unit length of any particular fibre had an almost constant upper limit, which was not greatly dependent upon the speed of rubbing and humidity below about 70 per cent relative humidity. At higher humidity the charge fell rapidly to zero, and the electrification also became much less efficient at lower speeds. It is, however, difficult to assess accurately the actual densities of charge on fibres, and they were exchanged for strips of nylon film 5 mm. wide by 0·1 mm. thick. Results were substantially similar; a typical humidity characteristic is shown in the accompanying graph. The average charge density in the region A–B was of the order of 3 e.s.u. per sq. cm. for all rubbing speeds, loads and types of cylinder. The slope of section B–C was steeper for lower rubbing speeds.

The conductivity of wool and nylon increases rapidly and exponentially with atmospheric relative humidity[1], and it appears that above 70 per cent relative humidity the electrification is limited by conductivity through the hygroscopic polymer, which



Nylon film strip on 18 s.w.g. platinum wire

then exceeds 10^{-10} ohm^{-1} cm.$^{-1}$. The enormous increase in conductivity from zero to 70 per cent relative humidity (about 10^6 times) has no apparent effect, and some other factor must control the charge generated, imposing a constant limit which corresponds to an average electric stress at the film surface of about 12,000 volts per cm., or about half the breakdown stress in air at atmospheric pressure. It is suggested that the breakdown of the air is the explanation of the limiting charge. This is supported by the fact that films of polythene, which is non-hygroscopic, could be electrified to about the same value (actually 2·6 E.S.U./sq. cm.) and showed no sharp decrease at high humidity.

Discharge between the rubbing surfaces is difficult to demonstrate directly, but the potential difference set up would depend upon the dielectric strength of the gas in the intervening space. Air saturated with carbon tetrachloride has a considerably higher dielectric strength than air alone at the same pressure[2], and it was found that the maximum charge density on nylon was increased by 50 per cent and on polythene by 100 per cent in such an atmosphere at 30 per cent relative humidity. An analogous dependence on gas pressure is to be expected, and will be investigated.

The above results refer to single, unidirectional rubs. Repeated rubbing gave somewhat higher values, but substantially the same behaviour, so that apparently a single rub is sufficient to produce local charge saturation at ordinary pressures. It seems, therefore, that a quantitative study of the mechanism of charge transfer at lower relative humidities must be conducted at high atmospheric pressures.

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[1] King and Medley, *Nature*, **160**, 438 (1947).
[2] Rodine and Herb, *Phys. Rev.*, **51**, 508 (1937).

Preparation of Deoxyanisoin and some Stilbenes: Reducing Action of Sodium Glycollate in Glycols

Deoxyanisoin is prepared by reducing anisoin on heating with alcoholic stannous chloride hydrochloric acid solution[1], or tin in alcoholic hydrochloric acid solution[2], or distillation with zinc in an atmosphere of carbon dioxide[3]. It has also been prepared by heating hydroanisoin with dilute sulphuric acid[4] (the product reported by this method had a melting point of 95°, which would be 15° lower than that of pure deoxyanisoin), or with a mixture of hydrochloric and acetic acids[3]. Hydroanisoin itself is obtained by electrolytic reduction of anisaldehyde in alkaline solution using nickel, platinum[5,6] or copper[7] as cathodes, or by the action of sodium amalgam on an ethereal solution of anisoin[3], or catalytic reduction of anisil or anisoin using platinum oxide[3].

In the present work, it has been found that on refluxing anisoin[7] (10 gm.) in sodium glycollate (1·4 gm. sodium in 30 c.c. ethylene or propylene glycol) on a wire gauze for 15 min., it is readily reduced to hydroanisoin, melting point 168° (about 6·75 gm.). The latter is readily converted to deoxyanisoin (m.p. 109–110°) on distillation in vacuum in presence of one drop of 10 per cent sulphuric acid.

On refluxing a mixture of anisaldehyde (16·8 gm.) in sodium glycollate (1·4 gm. sodium or 2·4 gm. sodium hydroxide in 30 c.c. ethylene glycol) on a wire gauze for 3½–4 hr., pure *p,p'*-dimethoxystilbene of melting point 210° (1·25 gm.), anisyl alcohol, melting point 24–25° (3·3 gm.; urethane derivative readily obtained, melting point 90–91°), anisic acid (0·16 gm.) and an unidentified product (8 gm.) which could be separated into two fractions, one of which (4·8 gm.) reduces alcoholic ammoniacal silver nitrate on heating, are obtained. The anisic acid and the corresponding quantity of anisyl alcohol (which is only a small portion of the anisyl alcohol formed in this reaction) are undoubtedly formed through Cannizzaro's reaction. Many investigators[8–11] have prepared *p,p'*-dimethoxystilbene by various methods. *p,p'*-Dibenzyloxystilbene, melting point 240° (a new compound), *p*-benzyloxybenzyl alcohol and *p*-benzyloxybenzoic acid are similarly obtained.

However, on heating anisoin (5 gm.) in alkaline glycerol (0·7 gm. finely divided sodium in 15 c.c. glycerol) in an oil bath at 190–195° for 1½ hr., anisil, melting point 133° (0·5 gm.) and showing no depression with an authentic sample, is obtained; its monoxime had a melting point of 131°. The rest of the anisoin is recovered unchanged.

The mechanism of the reactions leading to the above products will be published elsewhere.

Cannizzaro's reaction was readily carried out on heating the aldehydes (which are already known to respond to this reaction) for 2–5 min. with 2 *N* alcoholic sodium hydroxide solution (15 gm. of the aldehyde in 30 c.c. ethyl alcohol which contains 2·4 gm. sodium hydroxide; or 1·4 gm. metallic sodium previously dissolved in the alcohol); an almost theoretical yield was obtained.

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[1] Apitzsch, H., *Ber.*, **40**, 1803 (1907).
[2] Buck, J. S., and Jenkins, S. S., *J. Amer. Chem. Soc.*, **51**, 2163 (1929).
[3] Irvine, J. C., and Moodie, A. M., *J. Chem. Soc.*, 536 (1937).
[4] Rossel, A., *Annalen*, **151**, 25 (1869).
[5] Law, H. D., *J. Chem. Soc.*, 1512 (1906).
[6] Tafel, J., and Schepss, W., *Ber.*, **44**, 2145 (1911).
[7] Dewar, J., and Read, J., *J. Soc. Chem. Indust.*, **55**, 347 (1936).
[8] Kopp, K., *Ber.*, **25**, 600 (1892).
[9] Brand, K., and Matsui, M., *Ber.*, **46**, 2942 (1913).
[10] Stobbe, H., and Hensel, A., *Ber.*, **59**, 2254 (1926).
[11] Sah, P. P. T., and Yuin, K., *Chem. Abstr.*, **41**, 5869e (1947).

Ammodytes immaculatus, a New Species of Sand-Eel Found in European Seas

A post-larval sand-eel with a mean vertebral number of 72·0 occurs commonly in the macroplankton of the Celtic Sea and Plymouth area. Described as *Ammodytes* species IV, it was not attributable to a known adult, and the existence of another species of the family Ammodytidæ was in consequence anticipated[1]. An adult *Ammodytes* with a corresponding vertebral number has recently been identified in the Plymouth area. In appearance it is very similar to *Ammodytes lanceolatus* Lesauvage 1825, with a pair of vomerine 'teeth' in the adult and a non-protrusible upper jaw. The vertebral number of this adult and of the post-larval *Ammodytes* species IV is widely separated from that of the true *A. lanceolatus* from this and other areas.

An external character immediately distinguishing adult *A. lanceolatus* from adults of the new species is

	Vertebræ mean (range) n	Dorsal fin-rays mean (range) n	Anal fin-rays mean (range) n
A. lanceolatus			
Lesauvage		58	30
Plymouth	66·86 (66–69) 70	(55–58) 22	(28–30) 22
Irish Sea, Port Erin	66·88 (66–68) 40		
North Sea[2]	66·73 (65–69) 126	56·24 (54–58) 125	29·55 (27–31) 127
Baltic[2]	66·85 (65–69) 293	56·02 (53–59) 291	29·78 (27–32) 292
A. immaculatus			
Plymouth	71·86 (70–74) 42	60·23 (59–62) 34	32·61 (31–34) 34
Douananez[3]	72·09 (70–74) 78		

the presence in *lanceolatus* of a prominent black spot on each side of the snout just above the middle of the upper jaw. The snout of the new species is uniformly dark. Referring to this difference of marking, the name *Ammodytes immaculatus* is proposed for the new species.

It is evident from the vertebral counts given by Forest[3] that his specimens from Douananez belong to *A. immaculatus* and not to *A. lanceolatus*. Further observations on the new species are in course of preparation.

Until recently, only two species of sand-eel were commonly known in northern European waters: *A. lanceolatus*, the greater sand-eel, and *A. tobianus*, the lesser sand-eel. In 1934, Raitt[4] described a new species, *A. marinus*, occurring very abundantly in Scottish waters, and now known to have a wide distribution in the north-eastern Atlantic. He also found *Gymnammodytes semisquamatus*, the Atlantic smooth sand-eel, to be abundant off Scotland, although previously only a single specimen had been recorded from British waters[5]. *A. immaculatus* now increases the number of north European species of Ammodytidæ to five. This is of interest in relation to Raitt's statement, based on the work of other investigators, that "Sand-eels have long been recognized to be of highest importance in the economics of the sea. They form a large proportion of the regular diet of almost all our food fishes. . . ."[4]

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[1] Corbin, P. G., and Vati, V., *J. Mar. Biol. Assoc.*, **28**, 287 (1949).
[2] Kändler, R., *Kieler Meeresforschungen*, **5** (1), 45 (1941).
[3] Forest, J., *J. Cons. Int. Exp. Mer.*, **16**, 179 (1950).
[4] Raitt, D. S., *J. Cons. Int. Exp. Mer.*, **9**, 365 (1934).
[5] Günther, A., Cat. Fishes Brit. Mus., **4**, 386 (1862).

A New Strain of *Leptospira* in Israel

An outbreak of an epidemic of leptospirosis began in Israel in the middle of 1949 and is still continuing. From June 1949 until April 1950, more than a thousand cases were observed in a narrowly limited district—the plain of the Sharon. Some cases were very severe, showing hæmaturia, oliguria, azotæmia, jaundice, meningitis and episcleral injection; the death-rate was 2 per cent. Most of the sera of the patients agglutinated *Leptospira grippo-typhosa* and *Leptospira bovis*, the titres ranging from 1 : 200 to 1 : 20,000.

The course of the epidemic did not correspond to that caused by *Leptospira bovis*, which was described by Bernkopf *et al.* in 1947[1]. According to these authors, cattle infected with *Leptospira bovis* caused the epidemic of 1946–47, which affected mainly butchers, veterinarians and other persons handling infected meat. For the following reasons, the present epidemic must be ascribed to another source: its intensity and suddenness; its appearance in a limited area only, whereas infected cattle were found throughout the country without causing leptospirosis elsewhere; the appearance of the disease in settlements having healthy cattle or no cattle at all; and the statistically established fact that most of the patients were growers of vegetables.

Simultaneously with the outbreak, there was a distinct rise in the rodent population of the country, and a relation to the epidemic was suspected. Various rodents (*Rattus norvegicus*, *Mus musculus*, *Meriones tamaricinus* and *Microtus guentheri*), caught in the area of the epidemic, were examined for *Leptospira* and corresponding antibodies. Cultures were made on Schueffner's medium from the urine, kidneys, liver and blood, and dark-field examinations were carried out with the urine and kidneys. Furthermore, agglutination tests were made, with *L. grippo-typhosa*, *L. bovis* and a *Leptospira* isolated by us from the blood of a patient of the present epidemic. Absorption tests showed that serologically this last strain was related to *L. grippo-typhosa* and *bovis*, but not identical with either of them.

No leptospiras or their specific antibodies were found in mice and rats. Sera of 70 per cent of the voles caught in the infected area showed agglutinating titres between 1 : 200 and 1 : 3,000 against the three strains; leptospiras were found upon dark-field examination of their kidneys and were cultivated on Schueffner's medium. Neither antibodies nor leptospiras were found in voles caught in non-infested areas.

Leptospira-free voles, bred in the laboratory for several years, were infected by intraperitoneal injection of leptospira isolated from a human case. They appeared in the kidneys after eight days, and were excreted with the urine in large quantities although the animals showed no outward signs of illness. Three-weeks-old albino mice infected in the same way showed leptospiras in the blood during the first four days after injection. From the fifth day onwards, leptospiras could no longer be found in the blood but appeared in the kidneys, and from the sixth or seventh day onwards they were excreted in the urine in very large numbers, at least ninety-nine days after the infection.

This method is now being used for the isolation of leptospiras and the diagnosis of leptospirosis: blood taken from patients during the first five days of illness gave negative results on Schueffner's medium, but mice infected with it excreted leptospiras in the urine two to five days after the infection.

As neither *L. grippo-typhosa* nor *L. bovis* can be found in the urine of the mice following an intraperitoneal injection, it has now become possible to differentiate the new strain from them.

The etiology of the present epidemic has thus become clear. A new strain of leptospira is transmitted by a native vole (*Microtus guentheri*) which lives in a region characterized by heavy soils, excretes with its urine leptospiras in vegetable plantations, and causes an infection of gardeners and agricultural workers.

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April 4.

[1] Bernkopf, H., Olitzki, H. L., and Stuczynski, A., *J. Inf. Dis.*, **80**, 53 (1947).

Elimination of Kappa Particles from 'Killer' Strains of *Paramecium aurelia* by Treatment with Chloromycetin

CERTAIN strains of *Paramecium*, known as 'killers', contain in their cytoplasm particles, called 'kappa particles'[1], which are Feulgen-positive, and stain with Giemsa after acid hydrolysis[2]. Killers liberate into the culture medium a substance lethal to *Paramecium* not containing kappa particles, known as 'sensitives'. Kappa particles have many of the properties of cytoplasmic genes[3], but their size (0·2–0·5 μ in length), and their staining reactions, suggest that they may be parasitic micro-organisms[2–5] such as the rickettsiæ, viruses of the psittacosis-lymphogranuloma group, or even small bacteria.

In an attempt to decide between these two possibilities, killer *Paramecium aurelia*, stock *H*, was cultured in baked lettuce infusion which had been inoculated with *Bacterium aerogenes* containing 2 mgm. chloromycetin per c.c. The chloromycetin did not affect the culture density of *Paramecium*, but after nine to fourteen days it was impossible to demonstrate any kappa particles in the *Paramecium*, when stained with Giemsa after acid hydrolysis. These killers, after chloromycetin treatment, had also lost their capacity to kill *P* stock sensitives.

Chloromycetin is an antibiotic active against certain bacteria, rickettsiæ, and viruses of the psittacosis-lymphogranuloma group, and the above result is further evidence for classing kappa particles with these parasitic micro-organisms; but as another antibiotic, streptomycin, has recently been found to eliminate the chromatophores in *Euglena*[6], and in seedlings of higher plants[7,8] the reaction of kappa particles to chloromycetin is not conclusive evidence for their parasitic nature.

Miss R. T. Gilmartin, of the Osborn Zoological Laboratory, Yale University, has treated stock *51* killer *Paramecium* for up to seventy-two hours with concentrations of chloromycetin ranging from 0·02 to 1·25 mgm. per c.c. Under these conditions, the number of kappa particles per animal was reduced, but they were not completely eliminated[9].

Cultures of *Paramecium* for this work were kindly supplied by Dr. J. R. Preer, of the University of Pennsylvania.

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[1] Sonneborn, T. M., *Proc. U.S. Nat. Acad. Sci.*, **29**, 329 (1943); *Amer. Nat.*, **79**, 318 (1945).
[2] Preer, J. R., *Amer. Nat.*, **82**, 35 (1948); *Genetics* (in the press).
[3] Sonneborn, T. M., *Ann. Mo. Bot. Gard.*, **32**, 213 (1945); Cold Spring Harbor Symposium on Quantitative Biology, **11**, 236 (1946).
[4] Altenberg, E., *Amer. Nat.*, **80**, 559 (1946).
[5] Sonneborn, T. M., *Amer. Nat.*, **82**, 26 (1948).
[6] Provasoli, L., Hutner, S. H., and Schatz, H., *Proc. Soc. Exp. Biol. and Med.*, **69**, 279 (1948).
[7] Euler, H. von, *Arkiv. Kim., Min., Geol.*, **25a**, 1 (1948).
[8] Bracco, M., and Euler, H. von, *Klin. Arb.*, ii, **10**, 1 (1948).
[9] Gilmartin, R. T. (personal communication).

Strength and Fatigue

IT is generally thought that the very large forces which isolated muscles can develop when excited electrically would produce movements so violent as to endanger tendons and bones if they were available in voluntary contractions in normal life. Our strength is kept within bounds by the inability of the higher centres to activate the muscles to the full. In a prolonged effort, this limited capacity to drive anterior horn cells by an effort of will is the part of the neuromuscular apparatus most subject to fatigue, so that the observed falling off in performance is due to an even less complete nervous activation of the muscle fibres rather than to failure of the contractile mechanism itself[1,2].

Against these views stands a simple observation. A subject lays his arm on a table with his hand over its edge and palm upwards. The forearm muscles are exercised by repeatedly flexing the wrist against the resistance of a 10-kgm. weight held by a cord loop in the hand. At first it is easy to make a movement of full range, but after some fifty repetitions the wrist can only be half-flexed. Exercise is then stopped and at the same time the circulation to the forearm is arrested by inflating a blood-pressure cuff on the upper arm. Test movements made every minute show that muscular power does not recover so long as the cuff is kept on (up to five minutes), but returns to normal within one minute when it is released, whatever the interval after imposition. Circulatory arrest alone causes negligible diminution in muscle strength until ischæmic paralysis supervenes in about thirty minutes. The only straightforward interpretation of this experiment is that fatigue in this type of exertion is peripheral. Reid[3], however, avoided this conclusion in a somewhat similar experiment by supposing that inhibitory afferent impulses are set up in the forearm "protective against excessive prolongation of activity and undue development of fatigue processes in muscle", and this was apparently confirmed by observing that good contractions were maintained to electrical stimulation of the median nerve.

Such suggestions can only be refuted by a more elaborate quantitative investigation. For this purpose the adductor pollicis is a better muscle, for (with suitable experimental arrangements to prevent interference) it is the only muscle employed in voluntary adduction of the thumb and it can easily be stimulated electrically through the ulnar nerve without involving other thenar muscles. Voluntary and artificial contractions, therefore, occur in exactly the same muscle and can be validly compared. In this way it has been shown that: (1) the tensions developed by a strong voluntary effort and by a maximal motor nerve tetanus are closely the same; (2) both tensions decline equally during fatigue and remain the same during a subsequent period of circulatory arrest; (3) the muscle action potentials to nerve stimulation do not significantly alter, indicating that neuromuscular block does not develop. (Fatigue was not carried beyond a 50 per cent reduction of muscle strength.) Voluntary effort, then, can call up the full potential power of the muscle; fatigue is due to failure of the contractile mechanism itself and not to nervous factors. Presumably the same metabolic causes in the muscle underlie the fatigue of small voluntary movements, as have long been known from the work of A. V. Hill to limit severe exertions of the body as a whole.

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[1] Starling, E. H., "Principles of Human Physiology" (London, 1941).
[2] Bartley, S. H., and Chute, E., "Fatigue and Impairment in Man" (New York, 1947).
[3] Reid, C., *Quart. J. Exp. Physiol.*, **19**, 17 (1928).

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, September 25

INSTITUTION OF WORKS MANAGERS, LEICESTER BRANCH (at the Franklin Gardens Hotel, Northampton), at 7 p.m.—Mr. A. P. Young: "Industrial Management and its Human and Social Implications".*

(To be given on Friday, October 6, at 7.30 p.m., at the Mechanics Institute, Burton Street, Nottingham, and on Tuesday, March 13, 1951, at 7 p.m., at the Preston and District Building Trades Employers' Association, Starkie House, Starkie Street, Preston.)

Monday, September 25—Thursday, September 28

FARADAY SOCIETY (in the Department of Zoology, The University, Cambridge).—General Discussion on "Spectroscopy and Molecular Structure and Optical Methods of Investigating Cell Structure".

Tuesday, September 26

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Dr. P. H. Cook: "An Examination of the Notion of Communication in Industry".

PLASTICS INSTITUTE, LONDON SECTION (at the Waldorf Hotel, Aldwych, London, W.C.2), at 6.30 p.m.—Dr. R. G. Heyes: "The Chemical Industry and Plastics". (Members of the Plastics and Polymer Group of the Society of Chemical Industry are invited.)

Wednesday, September 27

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—25th Annual General Meeting; at 7.15 p.m.—Mr. Paul Adorian: Presidential Address.

Wednesday, September 27—Friday, September 29

NATIONAL SMOKE ABATEMENT SOCIETY (at Margate).—Annual Conference; Dr. D. T. A. Townend: First Des Voeux Memorial Lecture.

Thursday, September 28

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. H. W. Mohrman: "Elastic and Viscous Properties of Polystyrene in Solid and Liquid States".

Friday, September 29

FARADAY SOCIETY, COLLOID AND BIOPHYSICS COMMITTEE (in the Chemistry Department, The University, Manchester), at 10 a.m.—Informal Conference on "The Electrical Double Layer".

PHYSICAL SOCIETY (in the Physics Theatre, Birkbeck College, Breams Buildings, London, E.C.4), at 5 p.m.—Symposium on "Cosmic Rays".

Friday, September 29—Sunday, October 1

ROYAL STATISTICAL SOCIETY (at The University, Sheffield).—Conference on "Scientific Method in Industrial Production".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHEMISTS (Experimental Officer grade) at Ministry of Supply factories in South Wales and South-West England, for experimental work connected with the manufacture of explosives and acids and routine analysis of a more intricate nature—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.541/50A (September 30).

FORESTERS in the Forestry Department of the Division of Agriculture and Lands—The Secretary to the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (September 30).

GENERAL ASSISTANT ENGINEER in the Electro-Technical Research Section of the Research Branch in London—The Secretary's Office (Establishments), Applications Section, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, quoting A.E.91 (September 30).

RESEARCH POST IN EXPERIMENTAL PATHOLOGY—The House Governor and Secretary, Royal Cancer Hospital, Fulham Road, London, S.W.3 (September 30).

RESPONSIBLE LECTURER IN ELECTRICAL ENGINEERING—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (September 30).

SENIOR BIOCHEMIST in charge of the Endocrine Laboratory at Chelsea Hospital for Women—The Secretary, Queen Charlotte's and Chelsea Hospitals, 339 Goldhawk Road, London, W.6 (September 30).

TEACHER IN MATHEMATICS—The Principal, Norwood Technical College, Knight's Hill, London, S.E.27 (September 30).

UNIVERSITY GRADUATE with first- or second-class honours in botany, preferably with postgraduate experience in ecology, to undertake a comprehensive survey of heather moors with special reference to methods of management in relation to grazing value—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen (September 30).

CHEMISTS as Senior Assistants (Scientific) at factories in South Wales and Southern Scotland to supervise Assistants (Scientific) engaged on routine chemical analysis and to carry out routine chemical analysis without immediate supervision—The Ministry of Supply, Est. 3 (C) 1, Room 828, John Adam Street, London, W.C.2, quoting No. V.R.498 (October 4).

ORGANIC CHEMIST for the Plant Protective Chemistry Section, to work on problems of chemical control of pests and diseases of fruit and hops—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (October 7).

ASSISTANT LECTURER IN THE DEPARTMENT OF PHILOSOPHY—The Secretary and Registrar, University College of North Wales, Bangor (October 10).

ELECTRONIC ENGINEERS and PHYSICISTS (Experimental Officer grade) at Ministry of Supply Research and Development Establishments in the South Midlands—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.253/50A (October 10).

BRITISH JUTE TRADE RESEARCH ASSOCIATION'S RESEARCH GRANT for investigations by X-ray analysis and other methods into the fundamental structure and properties of fibres with particular reference to jute—The Secretary, University College, Dundee (October 14).

LECTURER OR ASSISTANT LECTURER IN ZOOLOGY—The Secretary, University College, Southampton (October 14).

SCIENTIST, Grade III (with a good honours degree in chemistry), in the Board's Coal Survey Laboratory at Chester—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/255 (October 14).

DIRECTOR OF THE INSTITUTE—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (October 16).

ANALYST to take charge of the Chemical Laboratory connected with Crop Testing—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

ANALYTICAL CHEMIST (with an honours degree and some industrial experience)—The Superintendent of Laboratories, British Scientific Instrument Research Association, Sira, Southill, Elmstead Woods, Chislehurst, Kent.

ASSISTANT EXPERIMENTAL OFFICERS in various Government Departments, and divided between (*a*) mathematical and physical sciences, (*b*) chemistry and metallurgy, (*c*) engineering subjects, (*d*) miscellaneous (including Library and Technical Information services)—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3068.

ASSISTANT MECHANICAL and ELECTRICAL ENGINEERS in the Directorate General of Works, which is responsible for the design, operation and maintenance of all ground mechanical and electrical works service on R.A.F. and Civil Aviation Stations at home and overseas—The Under-Secretary of State, Air Ministry, S.2(h), Cornwall House, Stamford Street, London, S.E.1.

BANANA RESEARCH OFFICER in Jamaica—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27059/260.

CIVIL ENGINEER, to be responsible for the design, layout and construction of ancillary buildings for large chemical factories—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

DIRECTOR OF THE SIR ALFRED JONES LABORATORY (to be used as a research station for tropical diseases) at Freetown, Sierra Leone—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1.

INSPECTORS OF AGRICULTURE (with a sound training in practical agriculture and a university degree or college diploma in agriculture or equivalent academic qualifications) in the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Inspector of Agriculture'.

JUNIOR SCIENTIFIC OFFICER (with a degree in general science, pharmacy or biology), for technical work in the Blood Transfusion Service Laboratories—The Regional Transfusion Officer, Royal Infirmary, Manchester 13.

OFFICER-IN-CHARGE, Camden Park Experimental Station (Agricultural), by the Government of St. Vincent, Windward Islands—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M/N/23443 (3F).

PRINCIPAL SCIENTIFIC OFFICER-IN-CHARGE of the Freshwater Fisheries Research Station, to be established at Fort Rosebery, Northern Rhodesia—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1.

PROFESSIONAL ENGINEERS in many departments of the Civil Service for a wide variety of engineering duties—The Secretary, Civil Service Commission, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3225.

RESEARCH OFFICER (Senior Scientific Officer), East African Agriculture and Forestry Research Organisation, to take charge of the chemical analytical laboratory—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1.

SURVEYORS to carry out topographical and cadastral surveys in Malaya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27076/28.

TECHNICAL OFFICER, for work mainly concerned with technical and administrative questions received from member firms and associations in connexion with the treatment and disposal of trade effluents—The Technical Director, Federation of British Industries, 21 Tothill Street, London, S.W.1.

WORKS ENGINEER at Capenhurst Factory, Chester, to be responsible for all factory engineering services—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.